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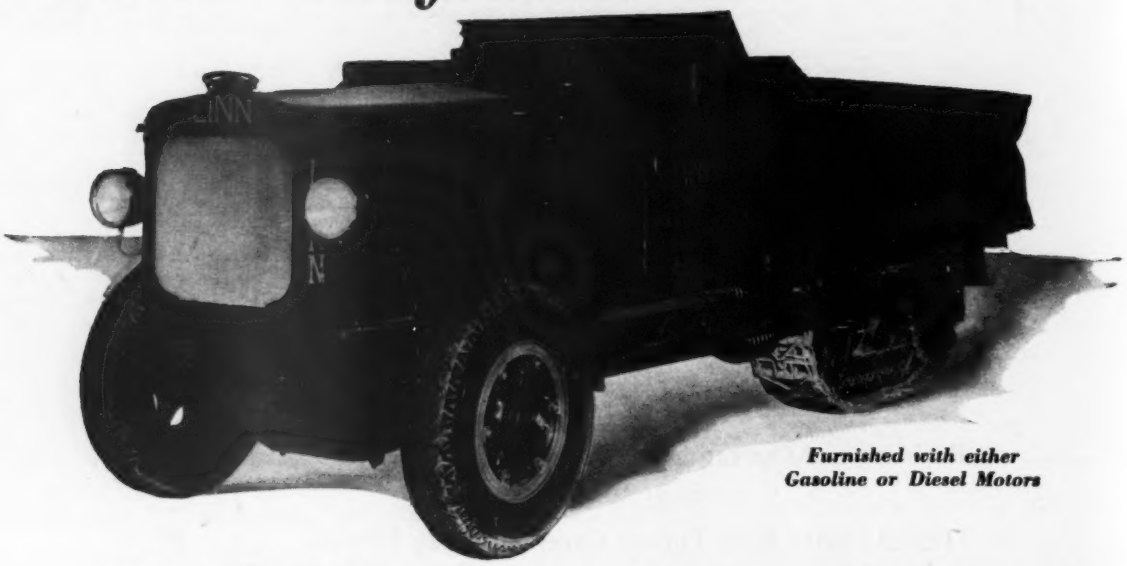

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Building and Operating the Nation's Lighthouses

Article IV in the series on engineering work in the federal government

WITH MORE THAN 20,000 aids to navigation scattered over the entire coast line of the United States and along all its navigable rivers, the United State Lighthouse Service carries on not only extensive maintenance work but a construction program of some magnitude. Establishment of new lights and fog signals, relocation of others and replacement of obsolete stations in a service now 143 years old necessitate new construction of great variety. Along with thousands of minor projects, there are usually several under way that command considerable engineering skill and the ability to carry on work under very unfavorable conditions.

The present and past year have been no exceptions in the matter of importance of stations constructed and their engineering features. Among the more difficult of its undertakings the Lighthouse Service numbers the isolated light and fog signal station at Anacapa Island off the California coast; the Cape Decision Lighthouse in Alaska, even more remote from supplies; the Detour Reef Lighthouse in Lake Huron, built upon a submarine site; and the Chicago harbor project, involving the remote control of several lights from a central station where a constant watch is maintained by the service.

A rocky island light location

Anacapa Island, a small rocky area of almost unscalable cliffs, derives its importance from the fact that it is on the route of trans-Pacific vessels approaching Los Angeles and of many coastwise vessels passing to and from Los Angeles via the Santa Barbara Channel. A lighthouse here was long recognized as a navigation aid of particular value, but the difficulties and expense of construction postponed work until only recently. Plans for the station and its construction necessarily took into consideration not only the requirements for landing building materials but the necessity of maintaining keepers at the station, running supplies and making future necessary repairs. Since the station was regarded as permanent, the matter of maintenance costs assumed an importance equal to that of first costs.

Principal features of the light station were to be a light tower, with provision for an electric light of great brilliancy; a fog signal to be operated by compressed air, with duplicate compressors and power units; a water supply sufficient for four keepers; and boats, derricks and necessary power for maintaining the station and service of supplies.

The preliminary work at the site was to consist of the building of landing facilities, which would later form part of

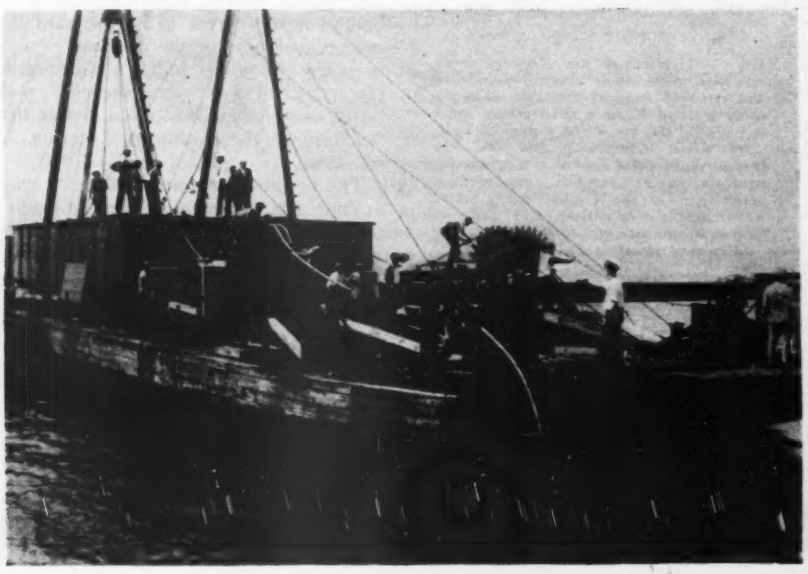
Fig. 1—Lighthouses are designed with reference to location, climate, foundation and types of material available. On the rocky coast of Maine a tall masonry tower is typical. On the inside waters of Delaware River, Chesapeake Bay and the sounds of North Carolina a low wooden structure on a screw-pile foundation is adequate. On the Florida coast, where hurricanes are prevalent and the sea bottom is sand or coral formation, a skeleton steel tower is frequently used.

the permanent equipment, the construction of a road on the upper part of the island and the concreting of a watershed and erection of water-storage tanks. As it was impracticable for supply vessels to lie close to the cliff sides, plans were laid to land all materials by means of small boats. Two landings were blasted out of the solid rock, one just above water level and the other about half way up the cliff. Each was equipped with a derrick, the lower one of a capacity to pick up both a small boat and its contents when necessary. The average work boat (about 30 ft. long) and the capacity of the hoists limited the unit sizes of all materials to be landed.

Construction of the landings proved both difficult and expensive. Caves and large cracks were found in what appeared on the surface to be solid rock, and rock slides seriously impeded the work. In addition to blasting the landings out of lava rock, heavy fills and concrete retaining walls and sea walls were required to make these landings usable and to protect the lower of the two from the action of the sea.

As there was no potable water on the island, a large concrete-slab rainshed was constructed, the water being led to two 50,000-gal. tanks for storage during the dry season. The buildings on the island consist of a separate house for each of the four keepers, a power house, a general service building, an oil house, a radiobeacon house, a fog-signal building, a 40-ft. light tower and an inclosure for the water tanks. Dwellings and power house are a modified Spanish type, and the other buildings are reinforced concrete with plaster finish. The light is electric, of 600,000 cp. Current for this, for general illumination and for the radiobeacon is furnished by three 5-kva. gasoline-engine-driven generators. The radiobeacon is a 110-watt set located in a separate building. The fog signal consists of two diaphones operating simultaneously but pointing in different directions. Compressed air for the diaphones is furnished by two gasoline-engine-driven vertical compressors.

Fig. 2—Installing power cables for the navigation lights erected in July, 1932, on Four-Mile Crib of the Chicago waterworks in Lake Michigan. Use of a car-float eliminated re-handling of the cables.



Offshore lights at Chicago

Carrying out the project for a general revision of the aids to navigation in Chicago harbor was hastened by the increased needs of traffic at the south end of Lake Michigan. The principal feature of this work was the more efficient marking of the waterworks cribs, which are so located as to provide valuable sites for aids to navigation, well off the shore and near the track of vessels; also the cribs are themselves dangers heretofore inadequately marked. The heavy traffic bound to and from the ports at the extreme south end of Lake Michigan is seriously handicapped by the haze in this neighborhood due to industrial plants.

Modern methods of lighthouse engineering were applied through the establishment of a central control station, at which a 24-hour watch is kept, while the machinery at adjacent stations is controlled through 14½ miles of submarine cable and 1 mile of land cable.

Two former light stations have been consolidated into a single Chicago station, the central control point being at Chicago Harbor Breakwater Lighthouse. Here the keepers operate a powerful diaphone fog signal, a light of high power and a radiobeacon. By remote control they also operate the lights and fog signals at Four-Mile Water Works Crib, at Carter-Harrison Water Works Crib and at the north pier at the entrance to the Chicago River.

The Lighthouse Service took over the lighting of the two waterworks cribs and the fog signals from the city of Chicago. These lights, with the breakwater station, form a huge funnel, leading ships to the breakwater entrance.

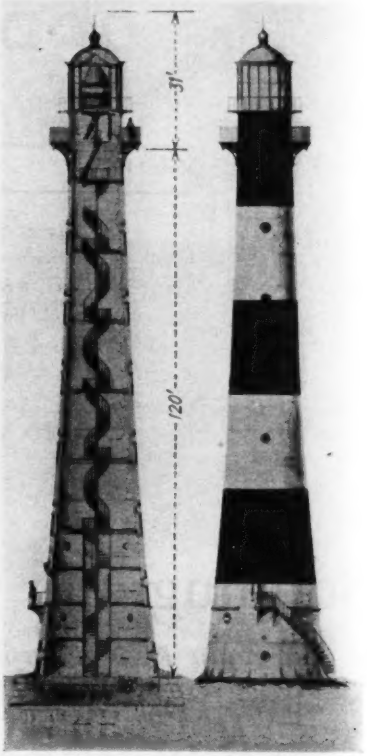


Fig. 3—Old cast-iron tower erected on Cape Canaveral, Fla., in 1873, on a pile foundation in sand. Later, when the encroachment of the sea threatened the tower, it was taken down and re-erected about a mile inland.

The power source for the entire system is at the shore end of the municipal pier, 1 mile to the west of the central station. Here connection is made with the city's control board. Current is received at 4,000 volts, 60 cycles, 3-phase, with grounded neutral. The four light stations forming the system are connected by a system of two entirely separate and independent parallel cables. One cable carries 4,000-volt current for power uses, the other carries 24-volt direct current for telephone and control circuits. Transformers and switch gear are provided at all four light stations.

Each of the two submarine cables to connect the breakwater and Four-Mile Crib stations was received in two pieces, one piece 1,200 ft., the other 17,000 ft., without splices. A 6,000-ft. cable, to extend from the north pier to the breakwater, was also received at the same time. This 42,400-ft. shipment of cable, received in three gondola cars, was run onto a car float. An A-frame was erected over each railroad car to facilitate the paying out of cable. The two parallel cables were paid out simultaneously, directly from the cars to the lake bottom, with a spacing of 25 ft. between cables. The entire lot of cable

was placed in one day, including the time required for four landings. The other 6,000-ft. cable, to extend from the north pier to the breakwater, came in a single gondola car. It was removed from the reels and coiled down on the deck of a flat scow, from which it was paid out onto the harbor bottom.

In the new tunnel, recently completed by the city of Chicago between the Carter-Harrison crib and the foot of Chicago Ave., the Lighthouse Service has been granted the use of four of the

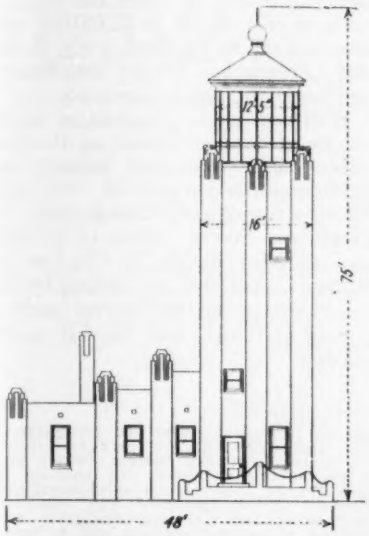


Fig. 4—Elevation of a modern concrete lighthouse now under construction at Cape Hinchinbrook, Alaska. Foundations are on rock, and construction is proceeding in a normal manner except for the difficulty occasioned by the extreme isolation of the site and the cold weather.

ten conduits in the telephone cable; and the city has also undertaken to furnish emergency service through its power cable, should this become necessary for lighthouse purposes at any time. In order to avail itself of the alternative route through the city tunnel, the Lighthouse Service has laid a signal cable along Lake Shore Drive between the north pier and the tunnel terminal. Reciprocal service will be afforded the city through the Lighthouse Service lake-bottom cable.

Modern mechanized signaling

Innovations and improvements in aids to navigation have been numerous in recent years. The design and installation of automatic lights and the development of new apparatus have been encouraged by the need for an increasing number of aids without seriously increasing the total cost. The increase in the number and brilliancy of lights on and off shore has led to the perfection of flashing lights in order to obtain adequate distinctiveness. The introduction of radio opened an entirely new field in lighthouse work. The radiobeacon has become one of the major aids to navigation, and the recent utilization of such signals for distance finding has necessitated the installation of precise equipment for timing and synchronization.

These tendencies have mechanized the lighthouse to a point not even dreamed of a generation ago. The lens used today was perfected more than 100 years ago, but illuminating apparatus and illuminants have passed through many stages of improvement. The illuminant used in lighthouses may be electricity, acetylene, incandescent oil vapor or kerosene. Wick lamps are still used but only in stations of minor importance. Where a more brilliant light is required selection of one of the other fuels is determined by conditions. Acetylene usually is used in automatic lights. Electricity is widely used, particularly where this form of power is also required for operating a fog signal or radiobeacon. Where commercial power is available, a stand-by plant is invariably installed, consisting usually of oil or gasoline-engine-driven generators. Duplicate or triplicate sets of such generators are installed where commercial current is not available.

At electrified stations lamps manufactured as standard commercial equipment are utilized when possible, but special bulbs have been developed when a wider filament is required by lenses originally designed for a much larger, although weaker, light source. For example the oil lamp has as many as five concentric wicks. On lightships, to counteract the effect of rolling, which throws the light beams either into the sky or toward the water, a lamp with a long filament is used to give a greater vertical divergence to the beams.

The power house of an important coastal light has gasoline- or oil-driven engines and generators for supplying electric current either continuously or as a stand-by where commercial power is used. The fog signal may be electrically operated or sounded by compressed air, with internal-combustion engines coupled to the compressors. These types have led to the gradual elimination of steam fog-signal plants. Generators must also supply current for the radiobeacon, for the light in the tower and for general lighting purposes at the station or vessel. To lessen the need of attention by keepers, automatic controls are provided so far as feasible. At a completely electrified station a control clock produces the required characteristic of the light, carries out in large part the somewhat complicated operating program of the radiobeacon, and sounds the fog signal when that is required. The light, of course, is shown from sunset to sunrise, flashing at regular intervals. The radiobeacon in clear weather is operated for portions of each of the 24 hours and must be synchronized with near-by radiobeacons. In fog most of these signals operate continuously for one minute out of every three. The fog signal sounds its characteristic blast at stated intervals; if used for distance finding, its blasts must be exactly timed with the dots and dashes signaled by the radiobeacon.

The control clocks are adjusted by the keeper, who advances or retards them daily to keep them in step with control clocks at near-by stations grouped in the same broadcasting schedule.

The keepers must manually start and stop the sound fog signal and the radiobeacon, in accordance with conditions of visibility, and for this purpose a continuous watch is maintained.

Maintenance of major importance

While the Lighthouse Service usually has one or more large projects under way, the greater proportion of its funds is required for maintenance, repair and minor improvements. Examples of this are to be found upon all parts of the coast. The recent placing of 66 buoys in the James River, a few miles above Hampton Roads, is typical of much work that follows the dredging of new

Fig. 5—The masonry tower at Minots Ledge, Mass., is built upon a rock foundation that is entirely submerged at high water. As shown, the lower courses of masonry are fitted into cut recesses in the rock. Wrought-iron dowels are employed to anchor the masonry to the rock, and to tie the masonry courses together up to the level of the first floor.

channels or the deepening of old ones by the Corps of Engineers. In addition to the cost of the buoys, this work involves the services of a tender for a number of days, as each buoy must be painted with the appropriate color characteristic, numbered, and soundings must be made in order to determine the most effective location for it. Bearings are taken to define the position of the buoy for the charts of the Coast and Geodetic Survey.

Marking of the Intracoastal Waterway, offering an almost continuous inside passage for small vessels from northern ports to the southern extremity of Florida, has been carried on almost without interruption for many years, but more rapidly since the government took over a number of privately owned connecting canals. The tortuous channels, often extremely narrow and passing through a landscape peculiarly devoid of prominent landmarks, have made night navigation largely impracticable in many sections, and restricted the marking of the channels mostly to the placing of day marks. Upon the Georgia and Florida sections of the waterway the Lighthouse Service employs a shallow-draft vessel to build beacons, take soundings and move markers with the shifting of the channels, marking new sections as they are dredged by the army engineers. At the most important inlets and harbors, where deep-sea traffic intersects the inside route, lights are erected on pile clusters.

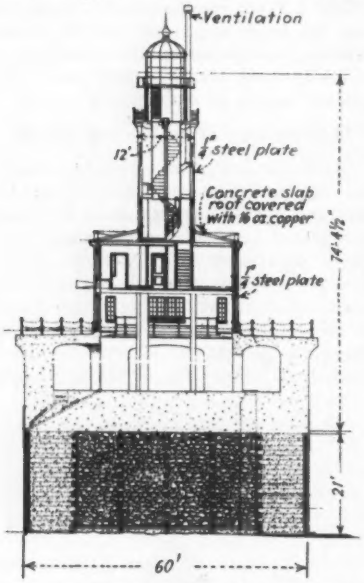


Fig. 6—Detour Reef Light Station in Lake Huron, Mich., an example of modern steel and concrete construction upon a submarine foundation in deep water. A timber crib was built on shore, towed to the previously leveled site and the center compartments filled with loose rock. The outer compartments were then filled with tremie-placed concrete, and a thick concrete deck was used to cap the crib. The lower story of the structure, housing the heavy machinery, is also of concrete, while the living quarters and tower are largely of steel plates.

Dictating the establishment of a light and fog signal at Cape Decision, Alaska, was the presence of a considerable volume of traffic which must here change course, because of the meeting of several channels, in waters studded with dangerous rocks and often enshrouded with fog. Construction of this station was complicated by the isolation of the site and the fact that all materials had to be transported by water. In order that a workable arrangement of buildings could be adopted, with the light established at a point where it could be best seen, it was necessary to level off a considerable area of rock. Concrete construction was used throughout. In common with other modern stations, Cape Decision was equipped with a power plant capable of generating electrical energy for the light and radiobeacon as well as compressed air for the fog signal. To insure reliability, much of the machinery was installed in duplicate, and facilities were provided so that the keepers could make ordinary repairs.

Indicative of the great variety of maintenance and reconstruction problems confronting the Lighthouse Service is the rebuilding of the station at Cape Hinchinbrook, Alaska. Originally built in 1910 upon a high bluff of solid rock, the structure has gradually become endangered by recent earth tremors causing rock slides that have left it perilously near the new face of the cliff. Estimates of the cost of moving the concrete lighthouse were prepared, but this plan was rejected, due in great measure to the advantages of a new structure built of a better grade of concrete and arranged to accommodate the latest types of equipment. Preliminary work during the past season was suspended for lack of funds but will be resumed next season, as $2,860,000 was appropriated in the Emergency Relief and Construction Act for establishing and improving aids to navigation.

With both services functioning under the Department of Commerce, there is rather close cooperation between the Lighthouse Service and the Coast and Geodetic Survey. All changes that the Lighthouse Service makes in its aids are published weekly in "Notices to Mariners," and these are utilized by the Coast Survey for the prompt correction of its charts and nautical publications.

* * *

THE LIGHTHOUSE SERVICE of the Department of Commerce is under the direction of the commissioner of lighthouses. The Washington office force consists of the commissioner of lighthouses, a deputy commissioner, a chief of engineering construction, a chief of marine engineering and other divisions necessary for the administration of the service. Actual construction and maintenance work are carried out through nineteen district offices, located in strategic parts of the country and usually in seaport cities. Each district office consists of a superintendent of lighthouses and the necessary engineering and clerical assistants. A typical lighthouse district may include jurisdiction over the navigational aids along 500 miles of coast as well as the waters tributary thereto. From one to six lighthouse tenders are assigned to each district, these vessels maintaining the buoyage system, building and repairing lighthouses and carrying materials and supplies to isolated stations and to lightships. Total appropriations for the Lighthouse Service for the present fiscal year were $9,850,000. Of this amount approximately $4,000,000 is allotted to general expenses, $50,000 to public works, and the rest to salaries of lighthouse keepers, crews of vessels and other personnel of the service.

Three-Year Record of California Contractor's Licensing Act

DURING the first three years of operation the California Contractor's Licensing Act resulted in bringing 1,442 contractors before the bureau of registration on charges of misappropriation of funds, abandoning uncompleted projects and other wrong practices. As a result, according to a report filed by the registrar, 273 contractors were suspended, the licenses of 39 others were unconditionally revoked and 232 were found guilty of operating illegally without a state license.

About 300 cases were adjudicated by arbitration after complaints were filed, but prior to formal hearings, and charges filed against 373 contractors were dismissed because of lack of evidence. In addition, hundreds of complaints were reported to have been filed, but these were settled after investigation without the necessity of filing formal charges.

Formal complaints involved a total of $614,250, and the benefits derived by the construction industry and the public are estimated to run into millions. This is possible because an unethical contractor may be cited for a complaint of only a few hundred dollars on a large job.

"The contractor's licensing act passed by the 1929 legislature was enacted at a time when the state was experiencing one of the greatest building booms in its history, and at a time when the operations of the unethical, unscrupulous and fly-by-night contractor, lacking in integrity, ability or financial stability, constituted a serious menace to the public. The chief accomplishment of the act has been to rid the state of this type of contractor, thus rendering an invaluable protection to the public as well as the subcontractor and other business men in the case where the contractor would collect the full amount of the project from his patron and then disappear without finishing the project or paying the material supply bills." This opinion of Carlos W. Huntington, registrar, summarizes the effect of the act during its first three years.

Tubular Steel Towers 52 Ft. High Carry Stiff-Leg Derrick

Unusual stone-handling rig designed for erection of Pittsburgh church—Steel grillage on light floor supports pipe towers

By C. Perry Streithof
Chief Engineer, American Tubular Elevator Co., Pittsburgh, Pa.

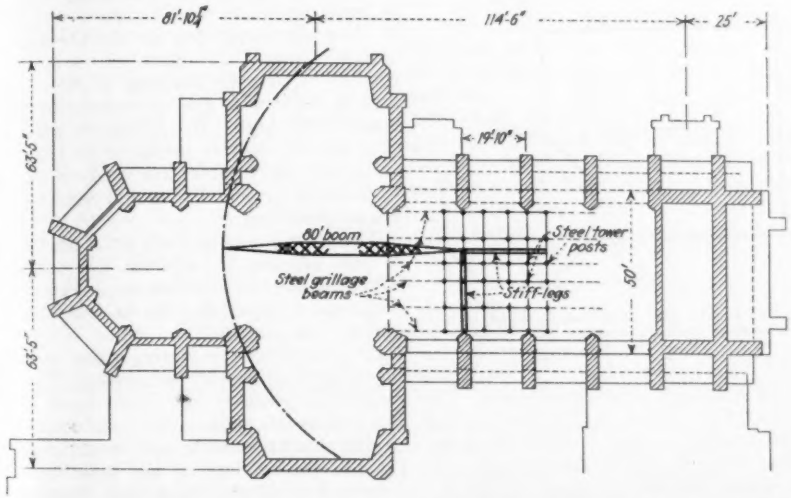
THE USE of three tubular-steel scaffolding towers to carry a heavy stone-handling stiff-leg derrick is an unusual feature being employed in the construction of the East Liberty Presbyterian Church at Pittsburgh. The church, a stone bearing-wall structure, covers a ground area of 127x221 ft. As tubular steel scaffolding is being used for the masonry work, the derrick installation was made without special equipment other than temporary steel and timber reinforcement of the light concrete floor upon which the derrick towers rest.

In order to place the stone economically, the stone contractor required a derrick capable of handling the blocks from a storage space outside the building and placing them in final position in any of the four main piers and arches. This necessitated an 80-ft. boom with an effective radius of 75 ft. Ordinarily the derrick would have been supported by the skeleton framework of the building. This structure, however, follows the Gothic type of architecture, not only in external appearance but also in the manner of construction, in that the walls and columns are of masonry. As the entire inside volume of the church auditorium was to be equipped with tubular-steel scaffolding, the stone contractor decided to utilize it as a support for his derrick. Three towers were erected, in advance of the walls, to a height of 52 ft. above the main floor. In this position the derrick was at about the same elevation as the springline of the arches.

The floor of the auditorium is of standard reinforced-concrete tee-beam construction, the beams running longitudinally and supported by steel cross-girders incased in concrete. As the design of the floor system was inadequate to support the heavy concentrations from the derrick tower posts, steel grillage beams were used to distribute these loads to the main cross-girders. These girders in turn were reinforced with heavy timber shores extending through three tiers of basement floors to the foundations.

The total compressive load under the mast reaches a maximum of 65,000 lb., including live and dead loads. The steel grillage beams on the top of the scaffolding distribute this load, so that

Fig. 1—With derrick set in nave of church, 80-ft. boom can reach four main piers and most of wall construction. Derrick will later erect stone spire.



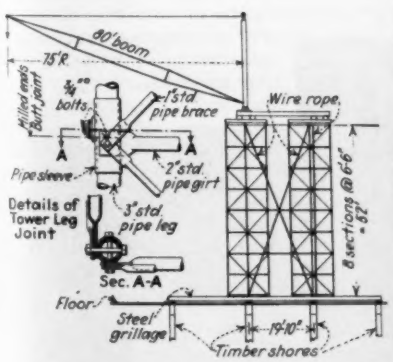
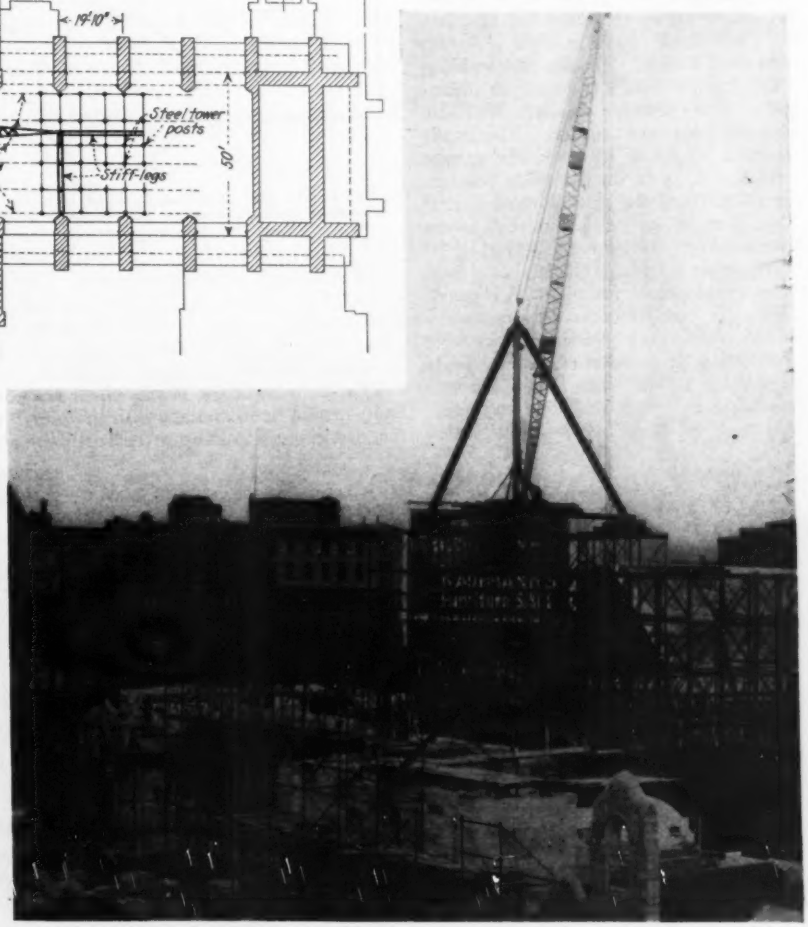


Fig. 2—Three towers of 3-in. pipe are sufficient to carry the derrick. Detail shows how all pipe posts are in direct compression at joints. Wire cable is lashed to stiff-legs, and floor beams take place of usual weight boxes in holding the stiff-legs in place.

Fig. 3—Heavy stiff-leg derrick with 80-ft. boom carried by tubular-steel scaffolding towers on Pittsburgh church construction.



the two legs under the mast take 50,000 lb., while the four outside legs take the remaining 15,000 lb. The design of the scaffold joint is such that the full area of the legs is developed in compression. The tension value of the joint, however, is limited to the strength of a ¾-in. bolt in double shear. Uplift under the back legs and mast of the derrick is taken by wire ropes running downward through the tower and lashed to the main-floor girders, relieving the tower from tensile stresses.

The capacity of the derrick is 4 tons on a redius of 50 ft., or 3 tons on a 75-ft. radius. The derrick is used principally to place all stones in the four main columns and arches. It is also used to distribute the stones for the walls to the proper working elevation, from which they are handled by 1-ton Chicago booms attached to the scaffolding towers.

In addition to the church auditorium, steel scaffolding is also used to surround the perimeter of the building, the interior of the Sunday School chapel, and will ultimately be used to erect the 200-ft. spire. The total amount of scaffolding involved represents some 40 miles of pipe.

The general contract for the construction of the church is held by the James L. Stuart Co., Pittsburgh. All stone is being set by Alexander Howie, Inc., of Cleveland, as subcontractor. The derrick towers and all steel scaffolding were designed and furnished by the American Tubular Elevator Co., of Pittsburgh.

Glass-Brick Walls Inclose New Buildings

THE FIRST commercial structure to utilize the new glass building block developed by the Owens-Illinois Glass Co. was completed recently in Columbus, Ohio. It is a combination gasoline filling and service station owned by the Ohio Oil Co., and the glass-block walls inclose a structural-steel frame. In plan the building is a rectangle 30x25 ft., with an octagonal office section having 7ft.10-in. sides forming one corner. The walls rise to a height of 15 ft. on the garage portion and 21 ft. on the office portion. The majority of the blocks are of natural color, but those used for trim were given a baked red enamel coating.

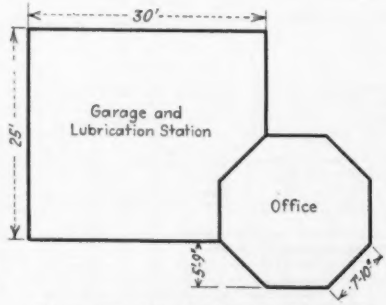


Fig. 2—The first glass-block building is a one-story structure made up of a rectangle and an octagon.

The glass building blocks have been under development for about two years. Test walls, erected at the manufacturer's Toledo plant, have yielded considerable information on installation requirements and service action. The blocks are hollow, being cast first with one end open. This end is then hermetically sealed under heat with a flat glass square. The standard-size block is $3\frac{7}{8}$x$4\frac{7}{8}$x8 in., and it will sustain a loan of 40,000 lb. on the gross area, or about 1,300 lb. per sq.in. of bedded surface.

The surfaces of the block, which normally would be in contact with the mortar, are given a coating of cement paint in the factory. This paint assists in bonding the joints and making them watertight, and it gives the block some suction, thus preventing mortar from dropping off while the block is being placed. Tests have shown that a good quality masonry cement is necessary and that a 1:2½ or 1:3 mortar is required. Preferably all sand should pass a 14-mesh sieve and should not deviate materially from the following analysis:

Not more than 8 per cent to pass 200-mesh sieve.
Not more than 23 per cent to pass 100-mesh sieve.
Not more than 40 per cent to pass 50-mesh sieve.
Not more than 70 per cent to pass 30-mesh sieve.

All blocks should be laid with full mortar joints about ¾ in. thick. Experience in erecting the filling station indicated that a good mason could lay about 500 blocks per day, and that the blocks resist breakage quite as well as glazed tile because of their comparatively thick walls.

World's Fair building

Although the first commercial glass-block building, the filling station is small compared with the building that is being erected at the Chicago Century of Progress Exposition by the Owens-Illinois Glass Co. Built of various-colored blocks, the building is 100 ft. long by 60 ft. wide and surmounted by a tower 50 ft. high. In addition to walls of glass, the roof is insulated by glass wool, and glass pillars are used up the front of the tower. Doors and windows are of aluminum.

The walls are in sections set at angles to one another to enhance the color effect. In the blocks of the more decorative type a vitreous paint is fused on during manufacture; in other blocks color is achieved by mixing paint with the factory-applied cement coating. The exposed or weather side of the block is in all cases left plain. The translucency of the blocks, which admits diffused light to the building, at the same time permits the reflected light from the colored surfaces to be diffused throughout each block, producing a pattern that changes continuously with the observer's perspective and with variations in interior lighting conditions.

Fig. 1—Filling station with glass-block walls built in Columbus, Ohio. Glass blocks are hollow and thus comparatively light in weight. Blocks used for trim are covered with red enamel baked on.

Fig. 3—Architect's sketch of glass-block building that is being erected at the Chicago Century of Progress Exposition.

Combining Concrete and Timber for Trestle Decks

A review of some early experiments with suggestions for rational economic design

By George D. Burr
Structual Designer, Hetch Hetchy Water Supply, San Francisco, Calif.

THE USE of concrete decks on timber trestles has been a subject of increasing interest in recent years due to the desirable qualities of the concrete surface and the low cost of the timber structure. Of three articles on the subject (*ENR*, Oct. 22, 1925, p. 683; April 1, 1926, p. 536; and August 25, 1932, p. 213), the last by C. B. McCullough, bridge engineer, Oregon State Highway Commission, showed the use of shear spikes and daps

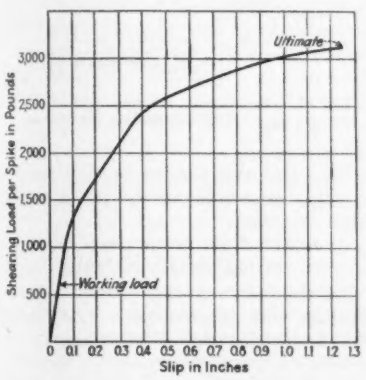


Fig. 1—Typical load-slip curve for ⅞-in. spikes in shear between concrete and timber.

in the top surface of the timber stringers to join the deck to the structure and to assist in distributing the load between stringers and deck. In order to realize the maximum benefit from this type of design, experimental data relative to the behavior of such construction should be available In the year 1924 the writer, then an assistant engineer in the county engineer's office, Seattle, Wash., conducted some experiments of this nature in cooperation with the city engineer's office of Seattle and with the University of Washington. An account of these experiments was published June 1, 1926, in Bulletin No. 37 of the University of Washington experiment station. The investigation included experiments with spikes tested in shear between timber and concrete, and also tests of full-size trestle deck stringers designed in the light of these preliminary experiments. The bulletin gives the test data and conclusions but does not give the method of calculation used. The method of calculation, which was verified by the full-size experimental test specimens, is given in this discussion, together with an abreviated summary of the test data.

The chief advantages to be gained by the combined use of concrete and timber in trestle decks are as follows:

1. The concrete deck provides a smooth, durable, anti-skid wearing surface, reasonably free from maintenance. It is substantially waterproof and protects the timber structure immediately beneath from the weather and from consequent deterioration.

2. Concrete and timber combined as a single member can produce a materially stronger beam than the same materials not so combined. This was shown by the experiments.

3. Increased stiffness is secured, thus reducing deflections and vibration. In the experimental members the combined materials were about eight times as rigid as the timber alone.

4. Rough timber may be used, resulting in a two-fold saving. The strength of the rough timber is greater than that of a surfaced one, and the cost of the surfacing operation on the stringers is avoided. The irregularities of the rough timber are taken up in the plasticity of the fresh concrete and assist in bonding the timber to the concrete.

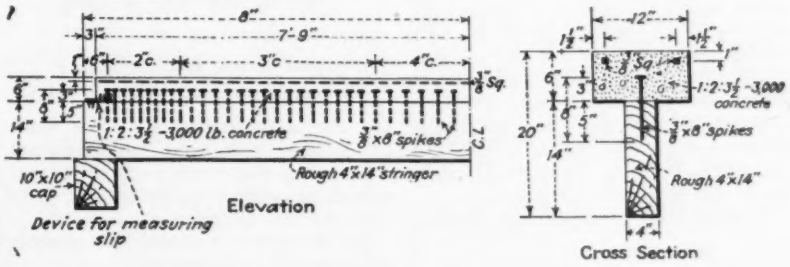
5. Form cost is small by reason of the small amount of formwork required, the simplicity of the forms and their adaptability to re-use.

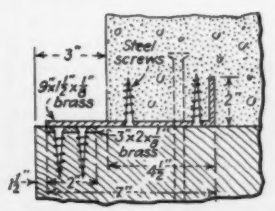
The accompanying illustrations relate to the early experiments. The timber used was about No. 2 common-grade Douglas fir. If structural-grade Douglas fir had been used, much higher ultimate loads would have been reached, probably in the order of 45,000 lb. per stringer.

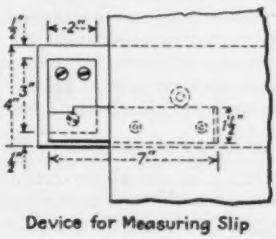
The experiments demonstrated that combined concrete and timber beams are subject to rational analysis when ordinary structural formulas are used for static loads or for loads repeated a limited number of times. Tests were not conducted for a large number of repetitions of loading. Spikes provide reliable shear members and are believed to be more economical than dapping. If chisel-pointed spikes are driven so as to cut the grain, it is not necessary to place spikes in drill holes. In the specimens tested ⅞-in. spikes were driven without difficulty on 2-in. centers, staggered ½ in.

The following points relative to such a type of construction are worthy of mention. Square boat spikes are not as desirable shear members as round chisel-pointed spikes. (See tests by Walker and Cross, *Journal* of Assoc. Eng. Soc., Vol. 19, December, 1897, for test data on nails and spikes in shear.) Boat spikes have a tendency to damage the wood fibers and consequently tend to have a larger slip at relatively small loads than round spikes, although their ultimate strength is as high. It may be necessary to soak timbers before driving spikes to avoid splitting, and in any event the timber should be thoroughly wetted before the concrete is placed. Timber has little longitudinal shrinkage, so that drying out after wetting will not be injurious to the structure.

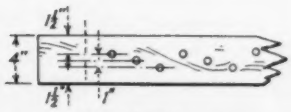
Fig. 2—Design details of full-size concrete-and-timber-deck test specimen.







Device for Measuring Slip



Top of Stringer

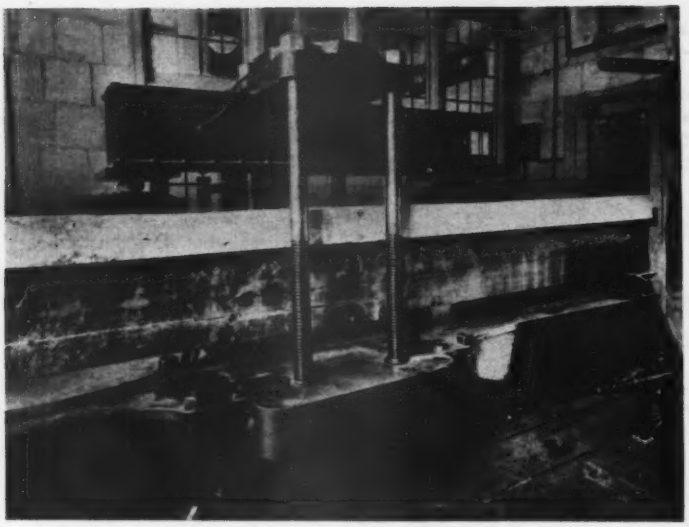


Fig. 3—Combination timber and concrete T-beam in testing machine, showing splitting of stem at failure. Loads are at third points, 5 ft. 2 in. from either end.

Shrinkage of the timber in drying and of the concrete in setting is in the same direction. Spikes should penetrate the wood not less than twelve diameters and preferably in excess of this amount. Spikes should not be driven closer than four diameters from the edge or from each other. If creosoted timber is used, allowance should be made for the plane of weakened concrete formed by the action of the creosote oil at the plane of the joint. The action on concrete of creosote oil is more pronounced when it has been freshly applied to the timber than it is after the oil has set for some time. Concrete should be adequately cured, particularly at the early stages, in order to prevent rapid drying out and consequent shrinkage. Repeated stress under field conditions may have an effect on the efficiency of the connection that can only be determined by long use of this type of construction.

The following formulas were used in the design of the test specimens:

Extreme fiber stress in concrete $= f_c = \frac{M_{LL}\, y}{I_{EC}}$

Extreme fiber stress in timber $= f_t = \frac{M_{DL}\, y_t}{I_t} + \frac{M_{LL}\, y'}{I_{EC}}$

Total shear on plane of joint $= \frac{Q_{EC}\, V}{I_{EC}}$

Working value of one spike in shear (lb.) $= (4000)\ (d)^2$

Number of spikes $= \frac{\text{(Total shear on plane of joint)}}{\text{(Value of one spike in shear)}}$

Spike spacing $= \frac{\text{(Value of one spike in shear)}}{\text{(Shear per linear inch at plane of joint)}}$

Or, the spike spacing for static loads or uniform loads may be determined by plotting the number of spikes required as ordinates against the live-load moment diagram.

In the above formulas the symbols have the following meaning.

d = spike diameter in inches.

V = (Total uniform live-load vertical shear) $= 2\int_{\frac{l}{2}}^{0} S_{LL} = 2M_{LL}$

S_{LL} = Live-load shear at any given vertical plane.

I_{EC} = equivalent concrete moment of inertia of section.

I_t = moment of inertia of timber about its own neutral axis.

M_{DL} = moment produced by dead load.

M_{LL} = moment produced by live load.

y = distance of the plane considered from the neutral axis of the composite section.

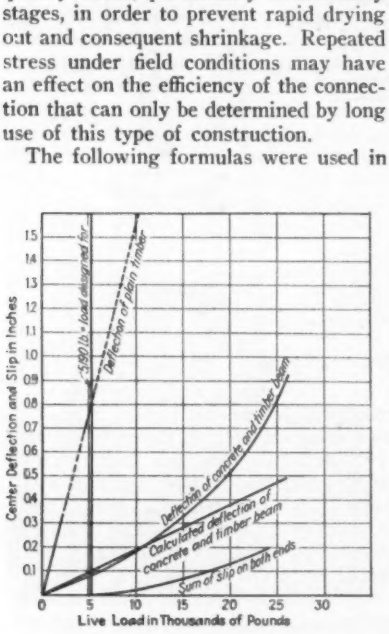

Center Deflection and Slip in Inches
Live Load in Thousands of Pounds
3,990 lb. load assigned for
Deflection of plain timber
Deflection of concrete and timber beam
Calculated deflection of concrete and timber beam
Sum of slip on both ends

Fig. 4—Load-slip and load-deflection curves for concrete and timber T-beam shown in Figs. 2 and 3.

Q_{EC} = static moment about the neutral axis of the portion of the section above the plane of the joint, calculated on the equivalent concrete section.

$(I_y)_{EC}$ = equivalent concrete moment of inertia about the neutral axis

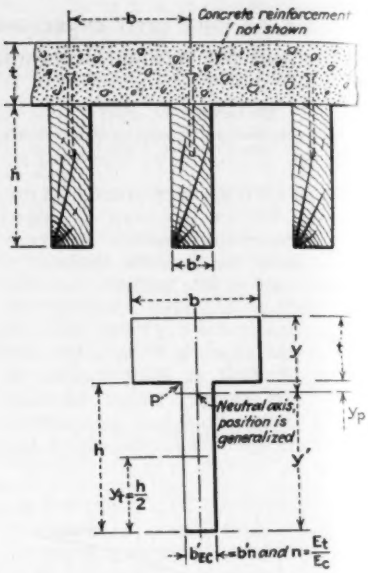


Fig. 5 — Equivalent concrete section of stringer upon which calculations were based.

of the portion of the section that is above the plane of the joint.

w = load per linear inch of beam at top surface of beam.

If a thin concrete slab is used in conjunction with large loads concentrated over limited lengths of the stringer, the vertical compressive stresses in the timber web at the plane of the joint with the concrete may become excessive. In such a case these stresses may exceed that allowable for cross-grain compression on timber, and they may be investigated further by the use of the following formula:

q = vertical compressive stress in the web

$$= \left(\frac{w}{b'}\right)\left[1 - \frac{1}{I_{EC}}\left\{(I_y)_{EC} - y\, Q_{EC}\right\}\right]$$

Steel Ties in England

The use of steel ties on English railways is increasing steadily, and according to an official report they now represent 247 miles of single-track main line, or 0.7 per cent of the single-track mileage (exclusive of sidings) of the four large railway systems. The largest user is the Great Western Railway, which has some 400,000 steel ties on an aggregate of 185 miles of track. This railway has placed an order for 100,000 ties to be laid during 1933 on about 47 miles of track.

Proposed New Building Code for New York City—II

Comparison with code now in force reveals radical change in make-up, increases in working stresses, reductions in floor loads, permission of structural welding, recognition of "controlled" concrete and better foundation provisions

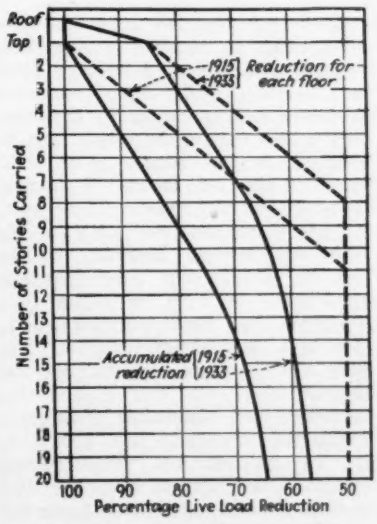
By Rudolph P. Miller
Consulting Engineer, New York, N. Y.

IN THE first half of this article, published last week, the requirements of the proposed New York City building code for foundations and for masonry construction were considered in comparison with the existing code provisions. In this concluding chapter the other principal divisions of the new code are analyzed. These include permissible floor loads, the necessary provisions and rules governing steel, reinforced-concrete and wood construction, and the requirements in the matter of fire-resistive building.

Floor loads

With one or two exceptions, the minimum live loads prescribed by the proposed code for floors devoted to various uses are the same as those adopted when the 1915 code was amended in March, 1930. While these provisions differentiate much more between floor uses than the old code did, the actual changes and their effects are not as great as a cursory reading might seem to indicate. For office floors there has been a reduction from 60 to 50 lb. per sq.ft., but this is offset by a specific requirement that an allowance of 20 lb. additional must be made for partitions; under the old code, partitions generally were regarded as part of the live load. The old code regarded all places of assembly, except class rooms in educational institutions, in one category, and fixed the live load at 100 lb. The proposed code distinguishes between one group, including class-rooms, churches with fixed seats and reading rooms; a second group, comprising theaters and assembly halls with fixed seats; and a third comprehensive group of "public spaces and congested areas," covering assembly halls without fixed seats, lobbies in hotels and public buildings, corridors not otherwise provided for, stairways, fire-escapes, basements and ground floors of hotels and business buildings, lodge rooms, art galleries and several other public occupancies. For these uses the prescribed live loads are respectively 60, 75 and 100 lb. For restaurants and dining rooms, in which there is no dancing or there is a maximum space of 1,600 sq.ft. for that purpose, a live load of 70 lb. is set. Under the old code, restaurants were classed as a business use to be designed for a live load of 120 lb. The most marked reductions are, no doubt, those from 120 to 75 lb. for ordinary stores, light manufacturing, stables and garages for pleasure cars. For other garages the uniformly distributed load is set at 175 lb. for the floor construction and at 120 lb. for the designing of beams, girders and columns, there being a further proviso that the construction shall be adequate for a concentration of 6,000 lb. at any point on a beam or girder. Trucking spaces (in buildings) and sidewalks must be capable of carrying safely a uniformly distributed load of 250 lb. per sq.ft. (300 in old code) and concentrations of 24,000 and 8,000 lb., respectively. For flat roofs the live load has been reduced from 40 to 30 lb.

The effect of these changes in live loads is, perhaps, more striking when applied in practice in connection with the revised provision for the reduction of live loads on vertical structural supporting members. The old code, prior to the amendment of March, 1930, required the assumption of the full live load of roof and top story and permitted a deduction of 5 per cent for the next story, increasing by 5 per cent for each lower story. The proposed code, on the other hand, permits the deduction to begin with the top story, starting with 15 per cent and proceeding by 5 per cent per story. In either case, however, not more than 50 per cent reduction may be made for any lower story. This rule applies to all classes of occupancy except storage buildings, in which the reduced assumed live load is limited to 85 per cent for all stories. In a twenty-story office building, because an addition of 20 lb. to the dead load must be made for partitions, there is no saving under the proposed code; in fact, the advantage is under the old code when more than four stories are supported; the average reduction in the gross load per story is about 3½ per cent more under the old code. For a twelve-story loft building (light manufacturing or display rooms), 75 lb. live load, and for a six-story factory, 120 lb. live load, there are marked savings under the proposed code. The reduced gross loads are, respectively, about 86 against 92 per cent, and 88 against 96 per cent.



Comparison of permissible live-load reductions by the existing and the proposed code. The savings with the proposed code, while actual for loft and factory buildings, are only apparent in the case of tall office structures in which 20 lb. per sq. ft. must be added for partitions.

Steel framing

Regarding steel and iron construction, the more significant differences beteen the proposed code and that of 1915 have already been in effect since the amendment of the latter in March, 1930 (*ENR*, April 10, 1930) a change accomplished by the American Institute of Steel Construction after five years of agitation. By that amendment the allowable working stresses in structural steel, in pounds per square inch, were increased from 16,000 to 18,000 in tension, compression on short lengths, and extreme fiber stress; from 20,000 to 27,000 in extreme fibre of pins; from 12½ to 43 per cent in shear. The bearing values remained unchanged in the case of single shear but were increased 25 per cent for double shear.

At the same time a new modified Rankine column formula was introduced, replacing the early A.R.E.A. straight-line formula and increasing the unit stresses, in the region of l/r values of 60 to 120, by about 30 per cent. (See diagram, *ENR*, May 8, 1930, p. 779.)

With respect to design and workmanship, the standard specification of the American Institute of Steel Construction has been taken as a basis, with some modification and additions, for the new provisions; much of the 1915 code has also been retained.

As standards of quality for structural steel as well as for cast iron and cast steel, A.S.T.M. specifications have been set. "Alloy and high-carbon steels may be used in accordance with the rules of the Board," and, by a rule, A.S.T.M. standards are prescribed for silicon and nickel steels; working stresses in tension are fixed at "30 per cent of the minimum ultimate strength, and other stresses may be increased proportionately to the corresponding

allowable stresses" specified in the code for structural steel.

The working stresses for cast iron and cast steel remain unchanged. The requirements in the use of cast iron for columns, lintels and bases are, almost verbatim, the present provisions.

Steel Joists—It has been generally assumed that the use of steel joists is not permitted under the present code, though there is no specific or implied prohibition. The proposed code gives them definite recignition (R 8. 6. 2. 7). Strictly interpreted, they can be used only in fire-resistive construction, since they "shall meet the requirements" of the code for fire and load tests of floors and roofs and for fire tests of long-span fire-resistive ceiling construction. They may be used only as "secondary members for floor fillers in structures 100 ft. or less in height, where the required live load is 60 lb. or less per sq.ft." Spans are limited to "550 times the lateral radius of gyration of the top chord" and to "24 times the depth of the joist," which would permit the deepest joist—20 in.—to have a span of 40 ft. But the deflection in any case, "as determined by test," must not exceed 1/360 of the span. A maximum spacing of 24 in. for floors and 30 in. for roofs is specified, except that when they support wood or sheet-metal roofs the spacing may be 7 ft. The provision for bridging is not clear but is apparently intended to require a rigid bracing at intervals of 6 ft. or less, well anchored at panel ends and so designed that the loads are fairly evenly distributed over several joists. The joists must be either painted, or dipped in asphalt meeting an elaborate prescribed specification, the quality of which must be certified by an approved testing laboratory.

All shop-fabricated steel must have at least one coat of paint before erection, except parts to be welded in the field, and these must be coated with linseed oil. After erection the steelwork "except that which is to be incased in concrete of non-corrosive aggregates" must be again painted so that all parts have had at least two coats.

Welding and Gas-Cutting—Fusion welding is authorized, by an ordinance provision, to be done "under rigid inspection and specification" (§ 8. 6. 2. 2). The requirements, incorporated as rules, limit the work to "duly qualified welders" who have passed the tests "prescribed in the report of the Structural Steel Welding Committee of the American Bureau of Welding, dated September, 1931." In addition, "The architect or engineer designing or supervising the construction of a welded structure shall be experienced and skilled in such work." Both fillet and butt welds are permitted. The maximum stresses, in pounds per square inch, in welded joints are fixed at 11,300 in shear, 13,000 in tension, and 15,000 in compression "on section through the throat of a weld."

Gas-cutting for the fabrication of structural steel, subject to the rules, is also authorized by ordinance. The rules require that those desiring to employ it shall satisfy the superintendent of buildings "as to their ability to produce satisfactory gas cuts." It is prohibited on members under stress and may not be used "to replace the milling of surfaces" nor for the cutting of "undesigned holes."

Use of Bolts—"Special attention shall be given to the character of connections to secure rigidity" when the height of a structure exceeds four times its width. Toward this end riveting or welding becomes necessary. However, a much wider use of bolting is contemplated by the proposed code than under previous practice. The 1915 code required riveting for "all component parts of built-up columns, girders and trusses, including any splices in the same"; bolting was practically limited to cast-iron columns and to the connections of beams to girders. Under the proposed code bolting may be used throughout the construction if the height of the building does not exceed 125 ft. or 2½ times its width. In buildings going as high as 200 ft., provided the height is not more than 2½ times the width, the column splices may be bolted. These column splices must be riveted or welded when the building is over 200 ft. high; when the building is over 100 ft. high and the height exceeds 2½ times the width; and in any case when the height exceeds four times the width. Riveting or welding of the connections of beams and girders to columns and of beams to girders is required in all buildings exceeding 125 ft. in height and in "structures of a special character."

Reinforced concrete

Reinforced concrete under the proposed code, as specified in the only ordinance provision (§ 8. 5. 1) relating thereto (aside from numerous definitions that appear in the ordinance but are used only in the rules), is to be designed in accordance with "the generally accepted theory of flexure" elaborated in the rules. These rules are based on the joint code of the American Concrete Institute and the Concrete Reinforcing Steel Institute promulgated in 1928, of which fully two-thirds has been incorporated in them, to a large extent verbatim. The departures, however, are marked and important.

Average and Controlled Concrete—"Controlled Concrete" (R 7. 4. 3. 2)—that is, concrete of predetermined strength, a development since the 1915 code was enacted—is not only given full recognition, but its value and importance are emphasized. Its use is made compulsory "when concrete structures are designed to receive their full design loads at periods less than 28 days after being installed." Whenever its use is contemplated, preliminary tests must be made before building operations are commenced, to determine the ultimate strength that is to be used in the design. If, in the course of construction, a change in the constituent materials is made, new tests are required. The allowable working stresses are fixed as certain percentages of the compressive strength at 28 days. The values are the same as those prescribed in the A.C.I. code, except that those for direct bearing, columns and pedestals are respectively 1/5, 1/9 and 1/3 higher. When controlled concrete is used, rigid inspection and periodic field tests are required.

Provision is also made for the use of "average concrete," for which preliminary tests are not required. Two mixtures are specified: (1) "1 part cement to at most 5½ parts of separate volumes of fine and coarse aggregate, measured dry, with at most 7½ U. S. gal. of water per sack of cement," which is expected to develop a compressive strength of 1,750 lb. at 28 days; and (2) 1 part cement to 4½ parts aggregate with 6½ gal. of water representing a 2,200-lb. concrete. For the former mixture the allowable working stresses are the same as specified in the present (1915) code, which prescribed a 1:2:4 concrete; for the latter the stresses are proportionately higher.

For the reinforcing steel, except as provided for wind loads, the comparative allowable stresses, in pounds per square inch, are as follows:

	Proposed Code	1915 N.Y. Code	A.C.I. Code
Structural-steel-grade billet steel A.S.T.M. A 9-24	18,000	.....	18,000
Intermediate-grade billet steel A.S.T.M. A 15-30	20,000	16,000	20,000
Rail-steel bars (limited to straight or machine-bent bars) A.S.T.M. A 16-14	20,000	16,000	20,000
Web reinforcement.....	16,000	16,000	16,000
Cold-drawn steel wire A.S.T.M. A 82-27.....	20,000	20,000	20,000

A provision (R. 8. 5. 6) that has hitherto had no counterpart in the A.C.I. code, nor in building codes generally, fixes by formula the reduced fiber stress to be used in designing beams or girders that are not laterally supported, such as a girder carrying a load over an extended wall opening.

Slabs and Columns—In the treatment of floor slabs reinforced in two directions supported on four sides (R 8. 5. 11, including seven subsections), there is a very decided departure from the inadequate and confessedly conservative provisions of the A.C.I. code. The proposed rules are the result of an extended study and thorough discussion by the subcommittee that drafted them. The rules governing the design of flat slabs (as distinguished from the supported two-way slabs) with square or rectangular panels (R 8. 5. 25, including eleven subsections) are essentially the present rules, which were promulgated by the board of standards and appeals in July, 1920.

The design and fabrication of columns

is another feature of reinforced-concrete construction, the consideration of which has, in the light of the researches and tests since the present code was adopted, resulted in a series of formulas that differ materially from the older practice. Provision is made in the rules for four types: (1) longitudinally and spirally reinforced; (2) longitudinally reinforced; (3) structural steel incased in 3 in. of spirally reinforced concrete, designated "combination columns"; and (4) structural steel incased in concrete with both longitudinal and spiral reinforcement, known as "composite columns." No provision is made for the Emperger column as used in the McGraw-Hill Building in Chicago (*ENR*, July 25, 1929); in fact, cast iron is not recognized as a suitable material for either combination or composite columns. Permissible axial loads are given by the formula for each type. A general formula for "long columns" is added to provide for reduced loads when the limiting unit stresses prescribed for the several types would otherwise be exceeded. This formula evidently does not apply to combination and composite columns, in which the slenderness ratio of the structural-steel core is limited to 120. No column shall be less than 12 in. in diameter or least dimension, as in the present code, except that in columns that do not extend through more than one story such minimum may be 6 in.

The carrying capacity of bearing walls is to be determined by the corresponding formula for columns. A thickness of not less than 1/25 of the unsupported height, but not less than 6 in. in any case, is prescribed. This minimum thickness, which applies also to panel walls, represents a four-hour fire-resistance rating, as required for class 1 fireproof structures, in which class buildings of reinforced-concrete construction are included. So, too, on the basis of necessary fire-resistance, the minimum thickness of floor and roof slabs is fixed at 3½ in.

Wood construction

Under the proposed code the use of wood in building construction is greatly restricted. It is limited, as at present, to the interior construction of non-fireproof buildings and to frame buildings. While residence buildings of non-fireproof construction might still go to the height of 75 ft., the limit for office and mercantile buildings is reduced from 75 to 50 ft. (four stories) for certain restricted building areas dependent on location, and to 30 ft. (two stories) when those areas are exceeded though still kept within the maximum permissible area. Garages are cut down from a 50-ft. height limit to one story. All public buildings are limited to 20 ft. in height; while under the old code only those used as hospitals, asylums or detention buildings are so limited, others being permitted up to 40 ft. The state labor law is controlling in the case of factories, fixing the height for non-fireproof construction at four stories.

By the extension of the fire limits, wood-frame construction is to be prohibited except in residence districts in which, under the zoning ordinance, buildings are limited to 60 per cent or less of the lot area, and in certain areas in the boroughs of the Bronx and Richmond now practically developing as home sites. This type of construction, furthermore, is to be permitted only for three-story dwellings, 2,500 sq.ft. or less in area, and for one-story public buildings, 600 sq.ft. or less in area, except for private garages or stables on the same lot with a dwelling, and sheds, small outhouses and builders' shanties. The present code permits frame construction up to 40 ft. in height and 5,000 sq.ft. in area irrespective of occupancy, though within the suburban limits the construction is restricted to detached dwellings.

Grade-Marked Lumber—In fixing the quality of structural lumber the American Lumber Standards are designated as the proper criterion, "unless otherwise provided by the rules of the board." The introduction of grade-marked material is encouraged by permitting its use with higher working stresses. Certain grades for which working stresses are specified must be grade-marked. The recognized woods for beams and girders are long-leaf and short-leaf yellow pine; douglas fir (coast type); west coast hemlock; tidewater cypress; California redwood; red, white and Sitka spruce; and red and white oak, for which working stresses are specified (§ 7. 4. 7). A comparison with present working stresses cannot well be made, as the type of material that has come into use since the 1915 code was written has changed materially. The working stresses specified are those advocated by the lumber interests; they differ quite generally from those suggested by the Forest Products Laboratory (A.S.T.M. —D 245-27). For columns, the same woods are listed except hemlock, cypress and spruce. The allowable loads are generally lower than those permitted under the 1915 code; in the higher slenderness ratios they are about the same as A.S.T.M. recommendations, and in the lower ratios they are much higher.

Under the 1915 code wooden shingles were permitted on frame buildings outside the fire limits, irrespective of occupancy. By an amendment adopted in January, 1927, they were prohibited for new roofs wherever located, and were to be replaced on all existing buildings by 1942. Under the proposed code they may be used for isolated one-family dwellings outside the fire limits, edge-grain material only being allowed, with certain specified exposure according to the pitch of the roof.

Restrictions on the use of wood in buildings of fireproof or fire-protected construction are much the same as at present. Untreated wood would still be prohibited in buildings over 150 ft. high, except that moldings having a cross-sectional area of 2 sq.in. or less and veneers on treated cores or mounted directly on incombustible material need not be treated. Subdividing partitions, which at present may be, in the discretion of the superintendent, of untreated wood, must be, under the proposed code, of incombustible material or of fireproofed wood when the space within which they are used exceeds 5,000 sq.ft. In each story of buildings over 150 ft. high a single space of 800 sq.ft. or less inclosed by fireproof partitions may be trimmed or finished with untreated wood.

With some slight modification, the prescribed tests for fireproofed wood remain unchanged. Samples taken at the building may represent 3,000-ft. lots of a consignment, while at present samples are taken for every 2,000 ft. A new requirement prescribes that the tests shall be made in a fume hood. While now all three tests—crib, timber and shavings—must be satisfactory for acceptance, a consignment would be regarded as satisfactory if any two of the three tests were met.

Fire-resistive construction

Perhaps the greatest departure from the present code is proposed in connection with the provisions relating to fire-resistive construction. Performance under test, rather than definitely specified construction, has been made the basis of acceptance, although certain acceptable forms of construction are described to guide those who are still unfamiliar with results of investigation in this field. The time-temperature curve of the A.S.T.M. fire-test specification, C19-26T, is prescribed as controlling all fire tests. In the details of the test procedure, however, modifications of the A.S.T.M. standard have been made (R 10. 1. 12), and tests at variance with that standard are authorized; but "As an alternative method of testing, the standard fire-test specifications of the A.S.T.M. may be used."

Reinforced-concrete construction complying with the requirements of the code for that material is presumably satisfactory as fireproof (class 1) construction; that is, walls 6 in. thick and columns 12 in. or more in least dimension, with 2-in. protection for the metal reinforcement, have a *four-hour* fire-resistance rating; beams and girders with 1½-in., and floors with ¾-in. metal protection, have a three-hour rating.

The severity of the present code in requiring a four-hour rating for floors in fire-resistive construction, irrespective of the occupancy hazard, has been recognized. In the proposed code a three-hour rating is specified as the minimum for class 1 fireproof construction and a 1½-hour rating as sufficient for class 2 fireprotected construction.

The latter type is intended primarily to relieve residence-building construction of an unnecessarily high grade of fire protection. It would permit the use of the steel-joist floor construction.

Questionable make-up of code

The main purpose of this review of the proposed new building code for New York City has been to point out the more important changes in the requirements affecting the structural features of building construction and not primarily to discuss the merits of these changes. There are, however, a few provisions, the wisdom of which might be questioned and to which attention might profitably be directed.

As a basic matter it may be asked whether there has not been too much left to the rules, assuming, as is intended, that these may be changed, at will, by the board of standards and appeals. The new code, exclusive of the provisions constituting the rules, contains between 50,000 and 55,000 words, and is shorter than the present code by about 15 per cent. With the rules included, however, it approximates three times the length of the present one.

But it is not the matter of length or elaboration of details that prompts the question. It is the lack of direct relationship between some of the rules and some definite provision in the ordinance. There is no authority for the making of a rule unless there is some specific provision in the ordinance on which it is based. The general provision (§ 2. 2. 1. 1) that the board of standards and appeals "shall have power to adopt rules to secure the intent and purposes of this code" is not sufficient; in fact, it is believed to be ineffective because the power to make rules and the conditions under which they may be made are fixed by the city's charter, and the board of aldermen is without authority to delegate such power. As already stated, rules are justifiable only when they seek to carry into effect some statutory requirement.

Thus, in Article 5 there are only two general requirements in the ordinance, in few words, prescribing that structures or parts of structures shall be ventilated as required by the rules and that the design and installation shall conform to rules that may be adopted by the board of standards and appeals. There is no indication of a standard to be attained nor of methods to be used. Whether different requirements may be fixed for storage spaces or garages than for rooms for human occupancy is not specified. As embodied in the rules, such standards, methods and differences, which are undoubtedly fundamental, are subject to change at any time by the board of standards and appeals—in fact, immediately upon adoption of the code by the aldermen. There is nothing, for instance, to prevent a revision of these rules to eliminate ventilation by windows to the outer air and to require mechanical ventilation under all conditions.

As another example: under Article 8, entitled "Construction," there is a rule (8. 1. 2) prescribing conditions for "Workmanship on Welded Structures" and another (8. 1. 3) dealing with "Storage of Concrete Materials." These rules are wholly ineffective, as there is no intimation in the ordinance provision of the section, which these two rules are intended to carry into effect, that welding is permitted or recognized as a safe process, or that there are such things as concrete materials.

Again, referring to the section (§ 8. 6) on "Iron and Steel Construction" there are nine subsections constituting rules for the design of cast-iron columns; though the ordinance does not provide, as it does in the case of structural steel, for the use of the material, design in its application or workmanship in its installation. The only recognition of cast iron in the ordinance is a general provision (§ 7. 1. 3. 1) dealing with the quality of cast iron.

In the matter of arrangement it would have been better if the framers of the proposed code had avoided the method of numbering sections and rules suggested in the report of the building code committee of the Department of Congress. The New York building code constitutes a chapter of the city's code of ordinances. As such, the system for the identification of its provisions should certainly conform to that utilized for the other chapters of the code of ordinances. The scheme of the latter consists of numbered sections, divided into subdivisions, also numbered, and further subdivided when necessary into lettered paragraphs; and it has served its purpose satisfactorily. The proposed method of numbering sections and subdivisions, with the use of as many as four decimal points (five integers) in scores of sections of the ordinance and in hundreds of the rules, is confusing and subject to more frequent errors in the making of reports and the preparation of papers in the prosecution of violations than the method now in vogue. As proposed, the method does not even follow that described in the government report, for in this latter case not more than one decimal point is used. The term "decimal system" by which it has been called by representatives of the committee in control of the preparation of the proposed code, is a misnomer, as in numerous instances integers of two digits are found between decimal points.

Comments on technical provisions

Referring now to the technical provisions, in the section dealing with bearing values of soils "filled material" is classed with organic material, mud and silt, and is presumed to have no bearing capacity (R 7. 5. 2). This apparently would preclude the erection of a building on a bed of cinders or on a deposit of large stones from blasting operations, such as exist in certain localities of the city. Filled material of this kind has actually been used successfully for the support of buildings, when the necessity for excavating to natural bottom would have involved such an expense as to prohibit the development of the property.

Sand is defined as "small grains ¼ in. or less in size resulting from the natural disintegration of rocks." This definition seems to be based on the A.S.T.M. standard definition (C 58-28). The definition, being part of the ordinance, and therefore controlling throughout the ordinance and all rules that may be adopted, is too broad. It fixes no limit, as contemplated by the A.S.T.M. definition, on the percentage of ¼-in. grains that sand may contain. Such large grains are not objectionable in concrete, but sand containing them is unsuitable for mortar in masonry or for plastering.

Inasmuch as A.S.T.M. standards have been quite generally specified as criteria of acceptance, it seems somewhat inconsistent that the specifications for sand-lime brick (C 73-30) and concrete building brick (C 55-28T) are not included in the rules on quality of masonry materials.

High Brick Stresses—The standard set for acceptable brick is that designated as "grade B" in the A.S.T.M. specification (C 62-30). The best available information indicates that in the main the brick delivered in the New York market falls within that classification. For masonry of this grade of material the allowable working stresses (R 7. 4. 2. 2) seem excessively high. The building code committee of the U. S. Department of Commerce gave long and thorough consideration to this matter of working stresses in brick masonry, based on all available data and the results of special research at the Bureau of Standards. Its recommendations, issued in March, 1931, as a supplement to its report of 1925 on masonry-wall construction, are, for grade "B" brick, 175 lb. per sq.in. when laid in cement mortar, 140 lb. per sq.in. when laid in cement-lime mortar, and 75 lb. per sq.in. when laid in lime mortar. The corresponding values in the proposed code are 325, 250 and 100 lb. per sq.in., respectively, exceeding in the first and second cases even the values fixed by the government committee for masonry of grade "A" brick.

The wisdom of permitting 8-in. masonry walls for the top story of business buildings seems questionable. So far as direct load is concerned, there would seem to be no objection to the practice. But under present conditions bearing walls are more likely to be used in class 3 non-fireproof structures than in any other type. Fire tests on walls, as well as the experience of fire departments, show that there is a very marked outward deflection at the top of unrestrained masonry walls when exposed to fire within the building. Actual

measurements in fire tests of one-hour duration show as much as 4½ in. of overhang, which in a building of several stories would be much aggravated by the expansion of the walls of the lower stories. Adjoining properties are thus exposed to the danger of toppling walls.

The purpose for proposing the modified Rankine formula for steel columns is not clear. A comparison of the proposed formula with the A.R.E.A. formula (1929) and that recommended in the majority report of the Am.Soc.C.E. committee on stresses in structural steel (1925), both of which are straight-line formulas, shows a maximum variation for the slenderness ratios most frequently found in building construction (40 to 100), of only 6⅔ per cent, this being in the ratios below 50.

A study of the results of tests on full-size columns, as reported by the special committee on steel column research (Am.Soc.C.E.) and in Technologic Paper No. 328 (U. S. Bureau of Standards), raises the question whether the margin of safety has not been too greatly reduced by the use of any of the three formulas referred to. Analysis of the tests will show that, by the use of the formula of the 1930 amendment, the so-called factor of safety has been reduced nearly 20 per cent. In several cases the factor is as low as 1.7; the average factor is approximately 2.25. Considering that the applied test loads were truly axial loads, whereas in practice, eccentricity of loading, even if only slight, is almost unavoidable; and that in the handling in transportation and erection, unnoticeable bending is likely to occur; that permissible minimum live loads have been decreased for many occupancies, in some cases more than 35 per cent; that there has been an increase in the allowable reduction of live loads; that the assumed wind pressure has been materially lowered; and that it is regarded as unnecessary to make provision for secondary stresses or uneven settlements, further thought on this matter would seem to be desirable.

In fixing the minimum required fire-resistance rating of floors in class 1 fireproof buildings at three hours, a commendable change in the interest of economy has been made, without sacrificing safety. In permitting the use, in class 2 fire-protected buildings, of floors having a 1½-hour rating, however, it is believed that the margin of safety is not high enough. On the other hand, it is doubted whether the three-hour rating fixed for shafts and stair inclosures is necessary as a minimum requirement. As a fire partition—that is, one for "protecting life by furnishing an area of exit or refuge—" three-hour protection is hardly necessary. As a fire barrier—that is, to prevent the spread of fire from one part of a building to another—shafts and stair inclosures complying with the three-hour requirement would really afford a six-hour protection, whereas the floors, even in fireproof buildings, would offer protection for only half that time. A two-hour rating would seem ample for shafts and stair inclosures.

What appears to be a retrogression in the proposed changes in building regulation is the restoration of the permissible use of wooden shingles in certain parts of the city under given conditions. As recently as January, 1927, the board of aldermen, having in mind some trying experiences of the city fire department and the terrible loss of property and serious menace to life in some conflagrations outside the city fire limits, amended the existing building code after public hearing, to prohibit throughout the city the use of roofings on new buildings other than of "approved fire-retarding or incombustible materials."

Cost of Road-Mix Highway at Cobble Mountain Dam

Detail of methods and itemized costs of a 5-mile asphalt-stone road-mix highway approaching and traversing the crest of the dam for additional water supply of Springfield, Mass.

By Harry H. Hatch
Engineer in Charge, Cobble Mountain Reservoir, Westfield, Mass.

OF THE several new highways built by the city of Springfield in connection with the construction of the Cobble Mountain Reservoir, one section of more than 5 miles had to be surfaced before the county authorities would accept it. This highway, going over the Cobble Mountain Dam and spillway bridge, connects the towns of Granville and Blandford, Mass., and replaces some of the old country roads flooded by the reservoir. It was built about five years ago and was used extensively during the construction of the dam. It has a rock base and a gravel surface with an 18-ft. traveled roadway. Road oil had been applied in the past almost every year to save the highway under heavy construction traffic. The condition of the existing road was not uniform, varying from a very hard, water-bound surface to soft, muddy, country road. The latter was surfaced with bank gravel.

Due to the speed and the reasonable cost of road-mix construction, this process was adopted in hardening the surface of the highway. Crushed trap rock ¾ to 1¼ in. was spread by a spreader hooked onto trucks (Fig. 1). The spreader opening was set about 3 in. so as to give at least a 2-in. finished thickness. On the soft sections of the road special shoes had to be put on the spreader in order not to mix the material of the old surface with the crushed rock and to spread the latter to a uniform required thickness.

Asphaltic material No. 7 as specified in the "Manual on Road-Mix Types, Asphalt Road Construction Series" of the Asphalt Institute, was heated in the tank car before it was delivered on the job by insulated wagons. It was applied, at the rate of about ¼ gal. per square yard per inch thickness of road, by means of a pressure distributor, with temperature not less than 180 deg. F.

Fig. 1—Spreader on truck placing crushed stone for 2-in. finished surface.

The aggregates were mixed by the drag (Fig. 2). The ruts, depressions or ridges were graded, and the spots not affected by the drag were mixed by hand. The above operation was repeated.

The treated aggregate was rolled with a 10- to 15-ton roller after an initial set of about six hours and within 24 hours after mixing. This operation consisted of rolling the entire area at least twice. In case of any cross-sectional depressions and ridges, they were graded by additional mixed material and rolled again.

An examination was made of fat spots (isolated excessive asphaltic material); and if there were any, they were repaired either by adding clean aggregates or by replacing that particular spot with new properly treated aggregates and rolling. No traffic was allowed over the road at this stage, as the aggregate coated with asphaltic material would be picked up readily by the wheels of the vehicles.

Within about 24 hours after the completion of the rolling, ⅜- to ½-in. trap rock was spread by hand at a rate of about 13 lb. per square yard as keystone to increase the mechanical bond

Fig. 2—Asphalt applied by distributor was mixed with stone by drag.

of the aggregates. This was rolled into place. After a sufficient distance of road was finished with keystone and rolled, a third application of asphalt cutback, at about 200 deg. F., was applied by means of a pressure distributor at the rate of ¼ to ⅓ gal. per square yard. No traffic was allowed over this application, the so-called sealing coat, until after it was covered with ⅜- to ½-in. trap rock which was applied at the rate of 19 lb. per square yard. Then the road was rolled three or four times until the required shape and compactness were obtained. In case there was no shoulder or lateral support to the macadam surface, the edges were rolled down to knife-edge to be incorporated with the shoulder of the original road.

Before final rolling was completed, a careful examination was made to see that the entire surface had more than sufficient keystone to insure the necessary mechanical bond in the aggregates. In case of any excess cover over the sealing coat, it gradually will be moved by traffic to the edges of the road on tangents and to the outside edge on the curves.

The success of this type of road construction, as of others, will depend on the organization and efficient execution of the various successive operations. The work was so arranged that the various stages of the construction could proceed without interfering with the other phases, and so that, once the job was well under way, no equipment was kept idle waiting for some prerequisite operation to be completed.

Sufficient aggregate was spread and made ready each day for the asphalt cutback wagons on the following day. Enough area of road can be treated with asphalt and made ready to keep the roller busy the following day. At convenient intervals a sufficient quantity of keystone can be piled ahead so that it can be spread in an efficient manner at the required time.

The organization consisted of three men at the spreader box laying down the rock, followed by a shaping crew of about four men. A crew of four men operated the mixing drag with the aid of a tractor and operator. The mixing crew was followed by a crew of five men for final shaping, and the road was then rolled. Special gangs of five to fifteen men were used for spreading the keystone and later for covering the sealing coat. The quantities and costs involved are shown by the accompanying tables.

TABLE I — QUANTITIES OF MATERIALS AND COST TOTALS FOR ROAD-MIX HIGHWAY AT COBBLE MOUNTAIN DAM

Materials:		
Trap rock 1½-¾ in., 5,940 tons at 0.6965		$4,137.21
Trap rock ¾-¼ in., 860 tons at 0.995		855.70
Asphalt, No. 7 cutback, 64,607 gal at 0.0869		5,614.35
Hauling:		
Trucking trap rock, 6,800 tons at 0.58		3,944.00
Equipment rental:		
Spreader box, 22 days at 1.50		33.00
Tractor and drag mixer, 16 days at 18.00		288.00
Rollers:		
No. 1 45 hours at 2.25	$101.25	
No. 2 208 hours at 2.75	572.00	
No. 3 49½ hours at 3.00	148.50	
Trailer, 3 trips 56.00	168.00	
		989.75
Labor (mostly welfare gang at 40c. per hour)		1,843.35
Total for 27,000 ft. length		$17,705.36
Average cost per mile, 18 ft. wide and 2½ in. thick		3,462.38

Note: The crushed-rock quarry was about 15 miles away from the job, the round trip being around 30 miles. The cost of delivery and spreading per ton per mile was about 2c. The rolling expense is high, as it was impossible to get a good roller for the duration of the work, due to the distance from central locations. There were three rollers, 10, 12 and 15 tons each, sometimes two working simultaneously. A good new 15-ton gas roller would have been sufficient. Had this been obtained, the cost of this item both in Tables I and II would have been reduced about 37 per cent.

TABLE II — COSTS PER SQUARE YARD OF 2½-IN ROAD-MIX SURFACING AT COBBLE MOUNTAIN DAM

	Per Square Yard
Crushed trap rock:	
¾-1½ in. at quarry, .110 tons at 0.6965.	$0.0766
hauling, .110 tons at 0.58	0.0638
¼- ¾ in. keystone, 13 lb. at 0.995	0.0064
hauling, 13 lb. at 0.58	0.0038
¼- ¼-in. sealing-coat cover, 19 lb. at 0.995	0.0095
hauling, 19 lb. at 0.58	0.0055
	$0.1656
Ashphalt cutback No. 7:	
1st application .461 gal. at 0.0869	0.0401
2d application .462 gal. at 0.0869	0.0401
Sealing coat .272 gal. at 0.0869	0.0236
	$0.1038
Equipment rental:	
Birch spreader	0.0006
Tractor and drag	0.0053
Roller (including transportation)	0.0183
	$0.0242
Labor:	
Spreading and shaping ahead of drag	0.0083
Mixing	0.0047
Straightening up behind drag	0.0059
Spreading keystone	0.0059
Spreading seal-coat covering	0.0095
	$0.0343
Total cost per square yard road surface	$0.3279

TABLE III — PROGRESS AND PERFORMANCE RECORDS AT COBBLE MOUNTAIN DAM HIGHWAY

	Days
Construction period: July 25, 1932, to Aug. 20, 1932	24
Actually working	19.5
Applying asphalt	15
Mixing aggregates	15
Spreading sealing coat	6
Drag:	
Mixing (tractor and drag) 16 days, actual hours	110.5
Rate per actual working hour	$2.60
Roller:	
37 roller days, or actual hours	283.5
Rate per actual working hour, including transportation	$3.48

	Maximum	Average
Tons trap rock handled per day.	440	300
Gal. asphalt per day	8,050	3,330
Sq.yd. mixed per day	8,200	3,600
Sq.yd. sealing coat per day	19,800	9,000
Sq.yd. sealing coat per man per day	500	336

A general average of about 1,400 ft. of road, including all operations was obtained per day.

Forest to Be Used to Check Runoff Against Rainfall

Creation of an experimental forest, consisting of 13,000 acres in the headwaters of San Dimas and Big Dalton Canyons in Los Angeles County, Calif., for the purpose of studying over a long period of years the effect of watershed covering on runoff and erosion, has been announced by W. V. Mendenhall, supervisor of the Angeles National Forest. The experimental area is said to be the only one of its kind in the United States. It is proposed to conduct the experiment over a period of fifteen to thirty years, following a plan that has been worked out by Dr. W. C. Lowdermilk, senior silviculturist in charge of the United States Forest Service Experiment Station at the University of California.

The plan in brief calls for the placing of small dams in the mouths of three tributary canyons of Big Dalton at an elevation of approximately 2,500 ft., and the same number of dams in San Dimas Canyon tributaries at an elevation of 5,000 ft. Thus, forestry service forces will be able to check the runoff at the dams and the amount of rainfall on the watershed over the period of years, following which the chapparal will be burned off and comparative figures on runoff and erosion obtained. By setting up dams at the two elevations, the observers will be able also to determine the runoff from snow and rain, since much of the precipitation in San Dimas Canyon's upper reaches comes from winter snows.

Ten Years of Achievement With Rigid-Frame Bridges

Over 200 structures from 20 to 224 ft. in span have been built of reinforced concrete, in addition to several of steel-rib type with a maximum span length of 230 ft.

SINCE the first rigid-frame bridge was built in this country in 1922 by the Westchester (N. Y.) County Park Commission, this type of structure has enjoyed a rapidly growing popularity. Grade-elimination work, both in connection with railway crossings and the building of super-highways, has provided a field for the use of the rigid-frame bridge where its characteristics of economy in materials and substructure excavation, of minimum encroachment on headroom and of wide useful roadway opening have proved particularly advantageous. Among the state highway departments that have built rigid-frame bridges or have them under construction are California, Iowa, Arkansas, New York, Ohio, Colorado, Maine, Missouri, Kansas, Massachusetts, New Hampshire, Delaware, Connecticut, Utah and Washington. Structures of this type are also found in Denver, Los Angeles, San Antonio, Austin, Houston, Camden and Milwaukee. Westchester County has built nearly 80 rigid-frame bridges, and the Long Island Park Commission is just completing a program involving 22 bridges of this design. The U. S. Bureau of Public Roads utilized three rigid-frame bridges on its Mt. Vernon Memorial Highway. Ontario, Canada, has built a half-dozen, and twice that number can be found on the road system of New South Wales, Australia.

The most remarkable examples of the concrete rigid-frame bridge are to be found in Brazil, where Emilio Baumgart, a consulting engineer, has built a number of multiple-span structures far surpassing anything else yet attempted. For example, the longest concrete span elsewhere is about 100 ft. Baumgart's Herval bridge, illustrated herewith, has a central span of 224 ft. (*ENR*, Aug. 6, 1931, p. 208), while his latest structure, located in Rio de Janeiro, is made up of five spans of 39, 167, 172, 167 and 39 ft., respectively. The current year will see

Fig. 2 (above)—Constructing the largest steel rigid-frame bridge in this country, a 115-ft. span structure in Yonkers, N. Y. In Germany there is a bridge of this type with a 230-ft. span.

Fig. 3 (below)—Completed view of the steel rigid-frame bridge shown under construction in Fig. 2. The masonry abutments consist of a face wall and wing walls, retaining the fill of the approaches.

Fig. 1—Herval bridge in Brazil, with a span of 224 ft., is the longest concrete rigid-frame bridge yet built. It was constructed, without falsework, as two cantilever arms built outward in 5-ft. sections, an achievement remarkable for ingenuity and daring.

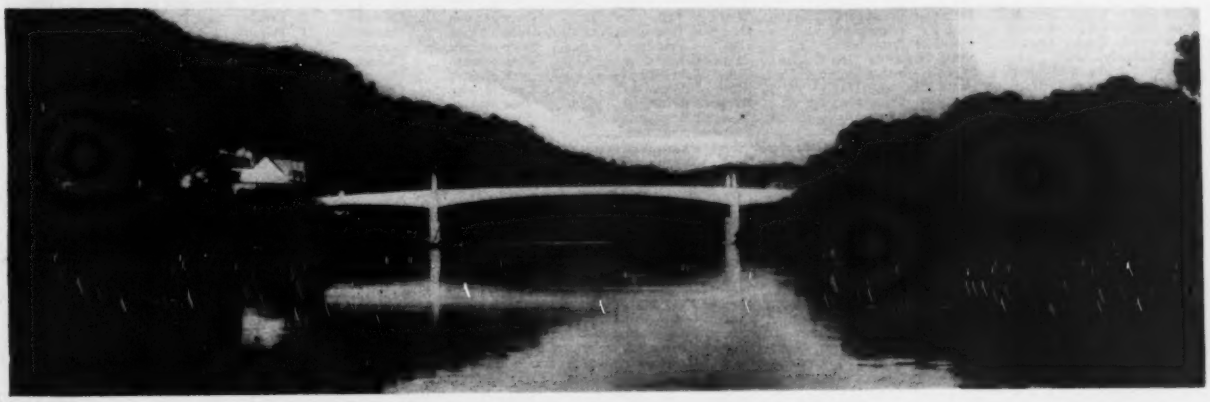


Fig. 4 (above)—Stone-faced concrete rigid-frame bridge of 56-ft. span on Hutchinson River Parkway, Westchester County, N. Y. The largest single-span concrete rigid-frame bridge in this country is the Martinez St. bridge in San Antonio, Tex., with a span of 101 ft.

two outstanding examples of multiple-span rigid-frame bridges built in this country, although neither of these structures will include a span of record-breaking length. The California highway commission has under construction in Los Angeles a bridge involving fourteen 65-ft. spans, while the Texas highway commission has begun construction on a seven-span bridge at Selma, Tex., with alternate span lengths of 59 and 90 ft.

These facts and the others given in the accompanying table have been assembled by A. G. Hayden, designing engineer of the Westchester County Park Commission, who introduced the rigid-frame bridge to this country and has been responsible for the design of a total of 84 structures of this type. All of these, except four, are of concrete, and most of the latter are of

Fig. 5 (below)—Two-span concrete rigid-frame bridge on Cross County Parkway, Westchester County, N. Y.

PARTIAL LIST OF RIGID-FRAME BRIDGES, PRINCIPALLY IN AMERICA

Location	Designer	Builder	Use	Mat'l	No. of Bridges	No. of Spans	Span Lengths, Ft.	Date Built
Westchester County, N. Y...	Bronx Parkway Comm.....	Bronx Parkway Comm.....	Grade separation	Concrete	7	Single	41–99	1922–1925
Westchester County, N. Y...	Bronx Parkway Comm.....	City of Yonkers, N. Y.....	Grade separation	Concrete	1	Single	41	1923
Westchester County, N. Y...	Westchester Co. Pk. Comm...	Westchester Co. Pk. Comm.	Grade separation	Concrete	43	Single	41–80	1925–1932
Westchester County, N. Y...	Westchester Co. Pk. Comm...	Westchester Co. Pk. Comm.	Over Streams	Concrete	6	Single	30–47	1925–1932
Westchester County, N. Y...	Westchester Co. Pk. Comm...	Westchester Co. Pk. Comm.	Grade separation	Concrete	2	Triple	10–46–10	1925, 1926
Westchester County, N. Y...	Westchester Co. Pk. Comm...	Westchester Co. Pk. Comm.	Grade separation	Steel	2	Single	88 and 100	1928, 1930
Westchester County, N. Y...	Westchester Co. Pk. Comm...	Westchester Co. Pk. Comm.	Grade separation	Concrete	1	Double	49–49	1929
Westchester County, N. Y...	Westchester Co. Pk. Comm...	Westchester Co. Pk. Comm.	Grade separation	Concrete	4	Double	44–44	1930
Westchester County, N. Y...	Westchester Co. Pk. Comm...	State of New York.....	Grade separation	Concrete	1	Double	44–49	1929
Westchester County, N. Y...	Westchester Co. Pk. Comm...	State of New York.....	Grade separation	Concrete	8	Single	42–56	1931, 1932
Westchester County, N. Y...	Westchester Co. Pk. Comm...	N.Y. Central R.R. Co.....	Grade separation	Steel	2	Single	46 and 73	1929
Westchester County, N. Y...	Westchester Co. Pk. Comm...	County Engineer.....	Grade separation	Steel	1	Single	115	1931
Westchester County, N. Y...	Westchester Co. Pk. Comm...	County Engineer.....	Grade separation	Concrete	1	Single	50.5	1930
Denver Colo.....	H. S. Crocker, Cons. Engr...	City of Denver.....	Over streams....	Concrete	1	Double	45–45	1926
Denver, Colo.....	H. S. Crocker, Cons. Engr...	City of Denver.....	Over streams....	Concrete	1	Double	39–39	1928
Westchester County, N. Y...	A.G. Hayden, Cons. Engr....	Village of Scarsdale.....	Grade separation	Concrete	1	Single	41	1927
Pocantico Hills, N. Y.....	A.G. Hayden, Cons. Engr....	J. D. Rockefeller, Jr.....	Grade separation	Concrete	1	Single	27	1929
Pocantico Hills, N. Y.....	A.G. Hayden, Cons. Engr....	J. D. Rockefeller, Jr.....	Grade separation	Concrete	1	Single	37	1929
Pocantico Hills, N. Y.....	A.G. Hayden, Cons. Engr....	J. D. Rockefeller, Jr.....	Over stream.....	Concrete	1	Single	30	1930
Pocantico Hills, N. Y.....	A.G. Hayden, Cons. Engr....	J. D. Rockefeller, Jr.....	Over stream.....	Concrete	1	Triple	24–46–24	1930
Connecticut.....	State Highway Dep't.....	State of Connecticut.....	Over stream.....	Concrete	6	Single	30–80	1927–1931
Danbury, Conn.....	State Highway Dep't.....	State of Connecticut.....	Grade separation	Concrete	1	Single	45	1928
Southington, Conn.....	State Highway Dep't.....	State of Connecticut.....	Grade separation	Concrete	1	Single	56	1931
Los Angeles, Calif.....	Dep't Public Works.....	City of Los Angeles.....	Grade separation	Concrete	6	Single	40–95	1925–1931
Los Angeles, Calif.....	California Highway Comm...	State of California.....	Over stream.....	Concrete	1	Single	21	1933
Los Angeles, Calif.....	California Highway Comm...	State of California.....	Over stream.....	Concrete	1	Double	38–38	1933
Los Angeles, Calif.....	California Highway Comm...	State of California.....	Over stream.....	Concrete	2	Double	30–30	1933
Los Angeles, Calif.....	California Highway Comm...	State of California.....	Over stream.....	Concrete	1	Triple	31–31–31	1933
Los Angeles, Calif.....	California Highway Comm...	State of California.....	Over stream.....	Concrete	1	Multi.	4 @ 27–33	1933
Los Angeles, Calif.....	California Highway Comm...	State of California.....	Over stream.....	Concrete	1	Multi.	14 @ 65	1933
Iowa County, Iowa.....	State Highway Comm.....	State of Iowa.....	Over stream.....	Concrete	1	Single	40	1927
New South Wales, Australia..	Dep't of Transport.....	Dep't of Transport.....	Over stream.....	Concrete	11	Single	25 to 41 with cantilever ends 6½ to 10½ ft.	1928
New South Wales, Australia..	Dep't of Transport.....	Dep't of Transport.....	Over stream.....	Concrete	1	Triple	20–30–20	1932
New South Wales, Australia..	Dep't of Transport.....	Dep't of Transport.....	Over stream.....	Concrete	1	Triple	30–40–30	1930
New South Wales, Australia..	Dep't of Transport.....	Dep't of Transport.....	Over stream.....	Concrete	1	Double	2 @ 35	1932
Pope County, Ark.....	State Highway Dep't.....	State of Arkansas.....	Over stream.....	Concrete	2	Single	24	1928
Cleburne & Franklin Co., Ark.	State Highway Dep't.....	State of Arkansas.....	Over stream.....	Concrete	3	Triple	3 @ 23	1928, 1929
Crawford County, Ark.....	State Highway Dep't.....	State of Arkansas.....	Over stream.....	Concrete	1	6	4 @ 45, 2 @ 60	1928
Crawford County, Ark.....	State Highway Dep't.....	State of Arkansas.....	Over stream.....	Concrete	1	4	4 @ 36	1928
Logan County, Ark.....	State Highway Dep't.....	State of Arkansas.....	Over stream.....	Concrete	1	10	10 @ 36	1928
Boone County, Ark.....	State Highway Dep't.....	State of Arkansas.....	Over stream.....	Concrete	1	10	10 @ 38	1931
Camden, N. J.....	Camden Co. Pk. Comm.....	Camden Co., N. J.....	Over stream.....	Concrete	1	Single	45	1929
Westchester County, N. Y...	N. Y. Central R.R. Co.....	N. Y. Central R.R. Co.....	Grade separation	Steel	1	Single	72	1929
Westchester County, N. Y...	N. Y. Central R.R. Co.....	N. Y. Central R.R. Co.....	Grade separation	Concrete	3	Single	40, 48 and 67.5	1930–1932
Long Island, N. Y.....	L. I. State Park Comm.....	L. I. State Park Comm.....	Grade separation	Concrete	11	Single	50–75	1929–1932
Long Island, N. Y.....	L. I. State Park Comm.....	State of New York.....	Grade separation	Concrete	11	Single	48–65	1929–1932
Rensselaer Co., N. Y.....	N.Y. State Dep't Pub. Works	State of New York.....	Grade separation	Concrete	1	Single	40	1932
Warren, Ohio.....	W. P. Brown.....	Trumbull Co., Ohio.....	Over stream.....	Concrete	1	Triple	71–74–71	1929
Ashland, Ohio.....	State Highway Dep't.....	State of Ohio.....	Over stream.....	Concrete	1	Single	40	1933
Putman Co., Ohio.....	State Highway Dep't.....	State of Ohio.....	Over stream.....	Concrete	1	Single	50	1933
Cuyahoga Co., Ohio.....	Cuyahoga County.....	Cuyahoga Co.....	Over stream.....	Concrete	1	Single	37	.....
Mt. Vernon Ave., Trenton, N. J.....	G. E. Beggs, Cons. Engr.....	Mercer Co., N. J.....	Over stream.....	Concrete	1	Single	60	1930
San Antonio, Tex.....	J.W. Beretta, Cons. Engr....	City of San Antonio.....	Over river.....	Concrete	1	Single	101.5	1930
New Braunfels, Tex.....	J.W. Beretta, Cons. Engr....	City of New Braunfels.....	Over river.....	Concrete	1	Triple	40–80–40	1931
Austin, Tex.....	H.R.F. Helland, Cons. Engr..	City of Austin.....	Over river.....	Concrete	2	Single	39	1930, 1931
Houston, Tex.....	J. G. McKenzie, Br. Engr....	City of Houston.....	Grade separation	Concrete	1	Double	21–21	1932
Wisbech, England.....	L. G. Mouchel & Partners....	.....	Over Nene R....	Concrete	1	Single	92.5	1930

PARTIAL LIST OF RIGID-FRAME BRIDGES—CONTINUED

Location	Designer	Builder	Use	Mat'l	No. of Bridges	No. of Spans	Span Lengths, Ft.	Date Built
Stuttgart, Connstatt, Germany			Over Neckar R.	Steel	1	Single	230	1930
Sta. Catarina, Brasil	Emilio Baumgart, Cons. Engr.	Federal Highway Comm.	Over Rio Jangada	Concrete	1	Multi.	77, 3 @ 93, 77	1930
Sta. Catarina, Brasil	Emilio Baumgart, Cons. Engr.	Federal Highway Comm.	Over Rio Preto	Concrete	1	Multi.	53, 3 @ 66, 53	1930
Sta. Cararina, Brasil	Emilio Baumgart, Cons.Engr.	St. Paulo-Rio Grande R.R.	Over Rio De Peixa	Concrete	1	Triple	76-224-86	1930
Rio de Janeiro, Brasil	Emilio Baumgart, Cons. Engr.	State of Rio de Janeiro	Over Rio Piabanna	Concrete	1	Multi.	38-119-119-36	1930
Rio de Janeiro, Brasil	Emilio Baumgart, Cons. Engr.	State of Rio de Janeiro	Over Rio Paraiba	Concrete	1	Multi.	39-167-172-167-39	1931
Federal District, Brazil	Emilio Baumgart, Cons. Engr.	Public Health Dept.	Over Rio Guandu	Concrete	2	Single	77	1931
Rio de Janeiro, Brasil	Emilio Baumgart,Cons. Engr.	Town of Barra do Pirai	Over Rio Pirai	Concrete	1	Triple	59-74-59	1931
Mt. Vernon Memorial Highway	U. S. Bureau Public Roads	U.S.Bureau Public Roads	Grade separation	Concrete	3	Single	44.5, 44.5, 46	1931
Province Ontario, Canada	Dep't of Highways	Province of Ontario	Over streams	Concrete	4	Single	33-57	1931
Province Ontario, Canada	Dep't of Highways	Province of Ontario	Over streams	Concrete	1	Double	44-44	1931
Province Ontario, Canada	Dep't of Highways	Province of Ontario	Over streams	Concrete	1	Triple	50-50-50	1932
Madison, Me.	State Highway Comm.	State of Maine	Over streams	Concrete	1	Single	30	1931
St. Louis Co,, Mo.	State Highway Dep't.	State of Missouri	Grade separation	Concrete	1	Single	44	1932
Dedham, Mass.	Fay, Spofford & Thorndike	Mass. Dep't Pub. Works	Grade separation	Concrete	1	Single	62	1932
Needham, Newton, Wellesley, Mass.	Mass. Dep't Pub. Works	Mass. Dep't Pub. Works	Grade separation	Concrete	5	Single	50-63	1932-1933
Newton, Mass.	Mass. Dep't Pub. Works	Mass. Dep't Pub. Works	Grade separation	Concrete	1	Double	2 @ 60	1933
Newcastle Co., Delaware	Del. State Highway Dept.	State of Delaware	Over stream	Concrete	1	Single	40	1932
Hillsborough Co., N. H.	State Highway Dep't.	State of New Hampshire	Over stream	Concrete	1	Multi.	2 @ 50, 2@ 60	1932
Black Bird, Del.	State Highway Dep't.	State of Delaware	Over stream	Concrete	1	Single	40	1932
Dover, Del.	State Highway Dep't.	State of Delaware	Over stream	Concrete	1	Single	50	1933
Milwaukee, Wis.	C. S. Whitney, Cons. Engr.	City of Milwaukee	Grade separation	Concrete	1	Single	66	1932
Kane Co., Utah	Utah State Road Comm.	State of Utah	Over stream	Concrete	1	Single	35	1932
Garfield Co., Utah	Utah State Road Comm.	State of Utah	Over stream	Concrete	1	Single	50	1933
Sevier Co., Utah	Utah State Road Comm.	State of Utah	Over stream	Concrete	2	Single	75	1933
Seattle, Wash.	State Dep't of Highways	State of Washington	Grade separation	Concrete	3	Single	77	1933
Prowers County, Colo.	State Highway Dep't.	State of Colorado	Over stream	Concrete	1	Single	20	1931
Glendale, Calif.	City Engineer	Los Angeles County	Over stream	Concrete	1	Single	52	1932

barrel design because, according to Mr. Hayden, this design proved more economical than a rib design for the materials and labor prices obtaining in the New York region prior to 1929. In Texas, on the other hand, it is said that the rib design has proved more economical for the prices obtaining since 1929.

The tabulation, although believed to be correct and complete, may lack some important structures that are true rigid-frame designs.

Helpful Hints on Sewer-Condition Surveys

Internal inspections of sewers disclose structural defects and deposits—Portable weirs give exact sewage-flow variation—Hazards to inspectors should be noted

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IN DESIGNING intercepting sewers and sewage-disposal plants accurate information regarding the operating capacities and the condition of existing sewers is essential. It is not sufficient in such problems to calculate capacities from data on file regarding the size and dimensions, material and grade of the sewers, because all too frequently existing sewers were not laid accurately to line and grade. Further, line and grade of sewers in service are often distorted by soil movements, by earth pressures, by structural defects in the sewers or by the erosive effect of sewage and stormwater flowing in the sewers.

When relief or intercepting sewers are being considered, plans and profiles of the existing sewers, showing graphically the conditions in the sewers as to velocities of the flowing sewage, deposits of sediment, trueness of line and grade and actual and required capacities in the sewers, are helpful in determining the proper design. For the design of sewage-disposal plants charts showing the hourly variation in sewage flow from the trunk sewers are necessary. Such gagings should be numerous and should cover a wide range of operating conditions in the system.

The labor involved in condition surveys of existing sewers by ordinary methods is considerable, and improved methods for simplifying the recording of data and for making observations are desirable whenever the project is of considerable consequence.

For some years the usual method of determining the flow in a sewer has been to install a weir and periodically to measure the flow or to use a head recorder with bulb located behind the weir. In sewers of small internal diameter it is exceedingly difficult to make such installations, and considerable labor is involved in installing a tight weir. Usually an existing manhole is the only available location for a weir unless readings at the outlet are desired. On many occasions it is necessary or desirable to know the flow of lateral sewers before the outlet is reached. To fit a satisfactory weir in an existing manhole, the services of a carpenter are necessary. A board must be shaped to fit the existing invert, and considerable trouble is usually experienced in keeping the joints watertight, even after calking with jute, clay or other materials.

Bicycle-Wheel Weir — The accompanying photograph illustrates a partial solution of this troublesome problem. The weir assembly is shown here at the outlet rather than in a manhole to obtain sufficient light for a satisfactory picture. The weir plate is welded inside a special bicycle-wheel rim on which is mounted a bicycle tire with a smooth tread. The weir is inserted in the pipe with tire deflated. When the tire is pumped up, a watertight seal is made between the inside surface of the pipe and the weir, with the tire conforming to the irregularities in the pipe surface. A standard head

Weir made of bicycle wheel with tire blown up snug against inside of sewer makes tight joint. Recording apparatus can be hung in manhole and manhole cover replaced.

recorder is used with a rubber bulb and about 15 ft. of armored tubing. The bulb is placed behind the weir and pushed up the sewer to a point where the flow over the weir is not visibly affected. The pointer on the recorder is then adjusted to read the depth of flow over the weir. Twenty-four-hour charts are used, and as many charts may be taken as desired, with little attendance. If it is desired to sample the sewage, the record provides a basis of accurately proportioning the samples in relation to the flows.

While the above arrangement has been called a weir, the discharge cannot be computed by the usual weir formulas, for as the flow increases the discharge more clearly approaches that of an orifice. For this reason each weir of this type must be calibrated for various heads and velocities of approach. In small sewers, where the velocity of approach is high, it is sometimes difficult to get an accurate measurement. It is under these conditions that inaccuracies from this arrangement are most likely to result. Also where considerable variations in head over the weir are found, or where considerable variation in the velocity of approach is found, the weir measurements must be used with caution, and great care must be used in interpreting the results.

This type of weir has been used with marked success for the past three years in sewers from 12 to 24 in. in diameter. While obviously not an accurate measuring device, it is thought to be as accurate as any weir that could be built in a manhole. When so used, the recorder with moisture-proof case is hung on a manhole step so that the cover may be placed on the manhole to avoid interruption to traffic during the flow test. The weir plate and rim now being used are cast in one piece of aluminum, which eliminates rusting and makes the assembly light and easy to handle.

The main advantage in the use of this device is its ease of installation and the fact that it requires little attendance. All flow data required on the average job can be obtained while the remainder of the preliminary data is being taken or assembled, without extra time or expense.

It is usually considered desirable to check the discharge as obtained from the weir measurements by measuring the elevation of flow in two adjacent manholes and figuring the discharge under the known factors of area of cross-section, slope and degree of roughness, by suitable hydraulic formulas. The flow measurements obtained from the weir charts are particularly useful in studying variations in the dry-weather flow. However, such calculations have in most cases checked the weir measurements closely and have substantiated the accuracy of the calibration of the weirs.

Collapsible Gage Pole—For taking elevations in manholes to determine grades of inverts the ordinary level rod is cumbersome. It can be supplemented by a collapsible gage pole made of an aluminum angle or T-section about 20 ft. long, similar to that ordinarily employed to check sewer grades during construction. The pole can be made up of one 10-ft. section, to which are hinged two 5-ft. sections. To the bottom of the pole should be fitted a horizontal base angle somewhat shorter than the internal diameter of the manhole cover. This base angle can usually be rested firmly on the invert of the sewer in the manhole, so that any irregularity in the invert through the manhole will not be reflected in the level readings. The gage pole should be fitted with a sliding horizontal rest plate to carry the base of the level rod, and this rest plate should carry a set screw so that the rest plate can be fixed at one of the even-foot graduations on the gage pole. The gage pole should be equipped with a spirit level so that the pole can be plumbed easily.

For observing the condition of sewers that are too small to enter, the use of two mirrors to transmit bright sunlight into the interior of the sewer is about as good a method as the writers have utilized. However, only first-class mirrors should be used, as cheap, poorly silvered mirrors are not satisfactory, especially when the sun is not bright. For use on cloudy days or in situations where the double mirrors cannot be used, certain types of flashlights that throw a beam of light instead of diffusing the light are useful. In one case, use was made of an automobile spotlight attached by a long cord to the battery circuit in an automobile parked at the manhole.

Inspection Trucks—Sewers as small as 27 in. can be inspected by entering them. For such inspections the writers have used a small flat truck fashioned and padded to fit a man's back and running on four small wheels. The inspecting engineer lies on this truck and propels himself along the sewer by using his hands and arms, the wheels being high enough to place the truck body above the dry-weather flow. A detailed inspection to detect the number and size of cracks in concrete pipe sewers was made with such apparatus at Niles Center, Ill., on several miles of 27-, 30-, 36- and 42-in. pipe sewers. The task was accomplished without undue fatigue. Observations were made and notes kept without difficulty.

Condition Recording—In making a condition survey recently of the sewers in Maywood, Ill., the writers divided all the sewers into four classes, which were shown by four colors on a sewer map of the town. Where velocities were good and there were no deposits of sediment, the sewers were marked "good." Where the velocities were only fair and deposits of sediment of 0.01 to 0.25 ft. were observed, the sewers were marked "fair." Where the flows were sluggish and deposits were noted from 0.25 ft. up to three-quarters of the diameter of the sewers, the sewers were "poor." Where worse conditions were noted, the sewers were marked "complete stoppage." Special conditions were noted on the map by symbols composing a proper legend, e.g., humps in grade, depressions in grade, bad variations in line, bad sewer-pipe joints, flattened arch, isolated deposits of mortar, bricks or other hard material, isolated sand deposits, isolated hard grease deposits, tree roots, cracked pipe, broken pipe, lack of proper invert in manholes, catchbasin leads broken, leaky manholes, manhole steps missing or in need of repair. This map was exceedingly useful in outlining a program for cleaning and repairing sewers, and subsequently after cleaning and repairing a revised map was useful in the design of a system of relief sewers. This map was also of great value in explaining to the municipal officials the problems involved.

Most people, including municipal engineers, are timid about entering large sewers. For condition surveys of large sewer systems such excursions are sometimes necessary. Comparatively few cases are on record where such inspections have resulted in injury or fatality to the persons concerned. There is but little contamination in the air of any ordinary sewers. The writers have spent as much as ten successive days in the interior of sewers without any ill effects to health and without experiencing any really unpleasant reactions. As one English authority has so aptly said, "Bacteria cannot jump out of the water."

However, since fatalities *have* occurred, it is always desirable, when condition surveys are being made, that some test be made of the sewer air. If it is laden with noxious gases, great care must be used by the inspectors.

The most dangerous sewers to inspect are those having flat grades, in which large masses of solids have collected. It is the digestion of the solids that produces the methane, carbon dioxide and hydrogen sulphide that make this work hazardous. The amount of deposits in a sewer can be ascertained roughly at the manholes by the use of mirrors or other methods as previously mentioned. In the case of large deposits there is usualy a strong septic odor at the manhole. Sewers with fair velocities and few deposits present little or no hazard on inspection. They are usually free from objectionable odors and dangerous gases.

Ventilation Essential—The inspector may protect himself from this gas hazard in many ways. Thorough ventilation of the sewer before entering it is the simplest and easiest method. This can be done by opening one or more manholes at the upper end of the line and at intervals along the sewer a

few days prior to the inspection. If the outlet is submerged, manholes near the outlet should also be opened for the admission of air. A noticeable draft should be produced. If there is insufficient draft, it may be advisable to force air in a manhole near the outlet with a blower. Standard equipment connected to the motor of a car or truck is now available for this purpose. Utility companies in Chicago have used such equipment with good results to protect the workmen who use torches within manholes. If, after the above precautions have been taken, there is any question regarding the sewer air, a test can be made by letting down mice in cages, these being more susceptible to the gases than humans. An ordinary army gas mask is of little or no use with gases of this nature, but masks have been devised for mine rescue work that are suitable for work within sewers.

While inspection is being made of the interior of sewers, it is essential to have a man at each end of the section under observation so that instant help will be available in case of emergency. Lighted lanterns, lighted matches or cigarettes have no place in a sewer. The inspecting engineers should always know how to reach a pulmotor squad quickly and should be trained in giving first aid to any of their number unfortunate enough to be overcome by sewer gas.

Work for Unemployed — In many cities relief sewers are needed today, and their construction is a good form of unemployment relief. Unemployed men, for example, can be used for the preliminary surveys under the direction of competent sanitary engineers. At Maywood, Ill., a city of 26,000, $7,670 was spent for condition surveys of the existing sewers.

When the condition survey has been completed, cleaning of the sewers and necessary repairs can be intelligently carried out by groups of unemployed men under the supervision of engineers.

Relief sewers usually involve construction work on improved streets, and necessarily much hand labor is involved for tunneling under existing sidewalks, pavements, water mains, gas mains, utility conduits and house-service pipes for water, gas and sewage. Hand labor is also needed for connections to existing manholes and sewers. In many locations, on work of this class, trenching can be carried out by hand as economically as by machines because of the many obstacles in the line of the work. Nicholas Santucci, a contractor, who recently constructed a system of relief sewers in Park Ridge, Ill., estimated that the wages for labor on that project in the built-up portions of the city constituted 70 per cent of his total expense.

Elevated Highways Proposed for Chicago

Traffic study indicates that capacity and speed can be obtained on elevated highways for less money per unit of efficiency attained than by street widenings

COINING the term "limited ways" for highways that have no grade-crossings and no direct access to abutting property, a new type of traffic facility has been proposed in Chicago as less expensive and materially faster than widened streets, which have been extensively developed in the past. The proposal, carrying recommendations for three trunk-line limited ways from the central business district to the west, northwest and southwest of Chicago, is contained in the second report of a city council committee on traffic and public safety headed by Alderman John A. Massen, with Miller McClintock, of Harvard University, as consultant. (For an abstract of the first report see *Engineering News-Record*, Nov. 24, 1932, p. 612.) The problem in Chicago is to accelerate traffic to country-road speeds through the congested areas on streets from the outskirts to the Loop. The report is addressed to the Illinois commission on future road program and gives a careful analysis of the factual data relating to this Chicago congestion problem. It covers types of limited ways, their economies and rational financial bases for their construction on a pay-as-you-go policy.

Types, capacity and speeds

Three types of limited ways are considered possible: (1) Surface routes, such as short stretches of park roads along the lakefront, separated from abutting property but giving access by marginal roadways, and having grade-separations for cross-traffic; (2) depressed ways, which are considered ideal as they least disturb cross-routes, but which require wide rights-of-way; (3) elevated ways, which require no disturbance in the grade of surface routes and simplify the right-of-way problem.

The capacity of surface routes in Chicago, in terms of the rate of flow per 10-ft. lane per hour, shows a wide variation ranging from 182 to 642 vehicles, with an average for eleven routes of 397 vehicles. Examples of capacities of limited ways are cited as follows: Holland Tunnel, 1,900 passenger vehicles per 10-ft. lane per hour and 900 trucks; Lake Shore Drive, south-bound, 1,232 vehicles; and Ericson Drive, 1,167 vehicles. With the most liberal estimate (642 vehicles) for the maximum capacity of surface routes, and with the most conservative (1,167 vehicles) for the free working capacity of limited ways, the latter have 81 per cent greater capacity.

A review of the general speed situation shows that there are only a few short portions of major surface routes in the entire greater Chicago traffic area that permit speeds in excess of 30 miles per hour. Vehicles on a great majority of the major routes throughout the city proper operate at speeds below 25 miles per hour, and many at lower speeds.

The question of the relative speed potentials of surface and limited-way routes is not one that needs to be answered on theoretical grounds. Conditions in Chicago have given as clear and complete a demonstration as could be desired. Attention is directed to the conditions existing on Ericson Drive and its connections to the south.

On Indianapolis Boulevard, with a substantial traffic flow, traffic encounters serious delays resulting in speeds of 15 to 20 miles per hour. South Shore Drive shows over-all speeds of 20 and 25 miles per hour due to lower route friction resulting partly from an elimination of commercial traffic and partly from lighter traffic volume. Through Jackson Park there is a further increment in speed resulting from the protected character of the route, there being few intersections and no stop-and-go control in off-rush periods.

Ericson Drive north of the park has accumulated a very heavy traffic volume and one which is augmented by several feeders along the approximate 5 miles of route between 51st St. and the central business district. In fact, this flow rates as the second heaviest traffic volume to be found in the greater Chicago traffic area. Notwithstanding this great volume and the fact that the route penetrates to the very heart of the metropolis, the speed characteristics of the route are a complete reversal of the experience to be found on other major surface routes approaching the central business district. Speed is in the maximum bracket, showing over-all operating characteristics of far better than 30 miles per hour.

The explanation is not obscure. Ericson Drive is of a limited-way type of construction. The major vehicular intersections have been eliminated, and there is no opportunity for access from private property. The over-all average speed of approximately 35 miles per hour, which is regularly achieved for

this great volume of traffic to the very heart of the city, is, however, a very conservative index as to the speed potentials of limited ways. Ericson Drive does not provide for a perfect nor complete separation of grades at all intersections. It is used to a considerable extent as a pleasure drive, and thus some portion of its traffic is usually comparatively slow-moving. Parking is not completely eliminated. Pedestrian access and crossing is possible at practically all points. Finally, the cross-section and the surfacing of the roadway are not such as to permit or encourage a utilization of the full-speed potentials that are inherent in the route. Despite these restrictions, a very substantial proportion of the heavy traffic volume does attain an over-all traffic speed of better than 40 miles per hour.

Actual experience in Chicago sustains the conclusion that, with the present stage of automotive development, it is possible and feasible to move heavy volumes of traffic to the very heart of the city by means of limited-way construction at average over-all speeds of not less than 40 miles per hour. And, furthermore, this can be accomplished in high-pressure districts where the maximum speed that can be attained by the most refined surface-route operation is not more than 20 miles per hour and where much present operation is below 15 miles per hour.

Cost determinations

A mile of surface route, operating at an average over-all speed of 20 miles per hour, or at a rate of three minutes per mile, and carrying a daily traffic of 50,000 vehicles, requires the expenditure of 150,000 vehicle minutes per 24-hour day. A mile of limited way, operating at an average over-all speed of 40 miles per hour, or at a rate of 1.5 minutes per mile, and carrying a daily traffic of 50,000 vehicles, requires the expenditure of 75,000 vehicle minutes per 24-hour day. The daily time-saving of the limited way as compared with the surface route is 75,000 min., or a money saving to operators of $937.50 per day computed at the rate of 1.25c. per minute. On the basis of 365 days the annual saving is $342,187.50, which may be capitalized at 5 per cent, giving a total of $6,843,750, or the capital expenditure justified per mile for limited-way construction over and above that required for surface-route construction.

For the relief of almost intolerable traffic conditions several notable widenings of surface routes have been undertaken and completed in Chicago in the past few years. Most important among the projects are Ashland Ave., Western Ave. and La Salle St. These three notable improvements cost an average of $384,000 per mile for each added effective 10-ft. or fractional traffic lane. Very careful design and cost-estimate studies lead to the conclusion that a six-lane elevated limited way of steel and concrete with liberal estimates for ramps can be constructed for a cost not to exceed $1,014,000 per mile.

It is believed that an average estimate of right-of-way cost, including legal costs and all possible damages that might be anticipated, may conservatively be placed at not more than $1,486,000 per mile, which, with construction costs, would result in a total per-mile cost of not more than $2,500,000, and in many cases the cost would be substantially lower.

On this basis six entirely new traffic lanes could be acquired by limited-way construction at a cost of $416,666 per lane-mile. This should be compared with the per-mile cost of $384,000 for each new traffic lane added in the three notable surface-widening projects discussed above. This direct comparison is, however, by no means fair. The new traffic lanes added by limited-way construction are not equivalent in traffic capacity to those added in the surface widenings. Each limited-way lane is not less than 81 per cent more efficient in effective traffic capacity. Thus, if the surface route cost of $384,000 per new lane-mile is taken as a norm, then the per-unit efficient capacity cost of each new limited-way lane per mile must be reduced from $416,000 to $230,000. In other words, as much effective capacity can be purchased at a rate of $230,000 per lane-mile in a limited way as was purchased for $384,000 per lane-mile in three notable major surface-route widenings in Chicago. This is basing comparative costs exclusively on the unit capacity purchased in the two types of construction and leaves out of consideration entirely the tremendous values in higher speeds and in accident reduction afforded by the limited way. Thus, if effective capacity alone is taken into consideration, the conclusion is inescapable that limited way cost is but 60 per cent of the three typical surface-widening costs.

The three base routes proposed for prior consideration total approximately 7 miles, and on the basis of a cost of $2,500,000 per mile would require the expenditure of $17,500,000. It is recommended that there be made available, for the construction of limited ways and collateral major traffic facilities in the greater Chicago traffic area, annual sums equivalent to one-third of the gas-tax contribution of the population of that area. Within the city of Chicago such an appropriation will make available somewhat more than $5,000,000 annually.

Administration

While not entirely specific, the report proposes that Cook County be the limited-way authority under which responsibility is unified for the initiation of planning and construction, but that there be given to Chicago effective power of approval or disapproval of plans or structures within the city. With respect to all details of construction and maintenance, it is proposed that full provision be made for supervisory control by the state through powers given to the Illinois department of public works and buildings.

Letters to the Editor

Spiral Steel and Column Strength

Sir—The conclusions published in your issue of March 16 from the result of column tests as reported to the American Concrete Institute are so contrary to the information I gathered from the results published in the "Third and Fourth Progress Reports on Column Tests at Lehigh University" that I am writing to inquire whether some error has not crept into your publication of the material. The conclusions 2 and 6 seem to indicate that the spiral reinforcement was practically of no assistance in resisting the loading of reinforced-concrete columns in the test referred to, whereas the progress reports above-mentioned give the following results for long-time tests:

On p. 18 the following statement is made:

> The strength of the columns increased quite regularly with an increase in the percentages of spiral reinforcement. The slope of the curves indicates an average effectiveness ratio of the spiral reinforcement of 2.0.

On p. 19 on the same report the summary of conclusions is tabulated, and items 19 to 22 have a direct bearing on this question. To me they give an entirely different picture of the effect of spirals in reinforced-concrete columns.

> 19. The strength of the columns having concrete of the same strength and the same total yield-point strength of the longitudinal reinforcement increased regularly with the increase in spiral reinforcement.
>
> 20. The effectiveness ratio of the spiral reinforcement was independent of the strength of the concrete. The average effectiveness ratio was 2.35 for dry-stored and 1.67 for wet-stored columns.
>
> 21. The ultimate strength of a concrete column having longitudinal but no spiral reinforcement may be considered equal to (*a*) 75 per cent of the cylinder strength of the concrete times the net core area and (*b*) the total yield-point strength of the longitudinal reinforcement.

22. The ultimate strength of a concrete column having both longitudinal and spiral reinforcement may be considered equal to (*a*) 75 per cent of the cylinder strength of the concrete times the net core area, (*b*) the total yield-point strength of the longitudinal reinforcement and (*c*) the total yield-point strength of the spiral reinforcement times its effectiveness ratio.

I have had considerable discussion with Professor Richart and the late Professor Slater on the function of spirals and their efficiency as column reinforcement, and have always felt their great part in resisting stresses ever since a test of a full-size column resisting over a million pounds pressure at Pittsburgh as far back as 1911. From the action of this column from the very beginning of the test to the capacity of the testing machine I was firmly convinced that the spiral performs perhaps the most important function of any of the reinforcement in the column.

I appreciate the fact that the discussion hinged upon the question of the action of the columns during the application of pressures within working stresses and those applied beyond that point to the ultimate strength of the column to failure, but I differ from the conclusion that the spiral does not function until the concrete and its longitudinal reinforcement is about to fail.

M. HIRSCHTHAL,
Concrete Engineer, D.L.&W. R.R.
Hoboken, N. J.,
March 21, 1933.

Architecture Is Not Engineering

Sir—I cannot help but appreciate the thought instilled by the letter of J. D. Galloway on p. 385 of the March 23 issue.

One wonders at times what is really the matter with our construction intellectuals, whether they be architects, engineers, or contractors. It would seem that they have so little faith in themselves that they spend much valuable time endeavoring to build legal fences to keep others out who may in many instances be even more capable than many of those who are within.

It is no secret that a university education and the ability to pay a registration fee does not make an architect, an engineer or even a good contractor. The inborn ingenuity, known otherwise as horse-sense, plus the mastering of the fundamentals is the reason for the success of the leaders in any field of endeavor.

There is no sensible reason for the non-cooperation between the various branches of the construction profession. We have many horrible examples of building design and construction as the result of such non-cooperation.

To get back to the beginning, let us see what the definitions are for architecture and engineering. Webster's says:

Architecture: The art or science of building; especially the art of building houses, churches, bridges and other structures, for the purpose of civil life.

Or to go back even further, Webster quotes: The formation of the first earth being a piece of divine architecture.—Burnet.

Engineering: The art and science by which the mechanical properties of matter are made useful to man in structures and machines.

Who will say that a line should be drawn separating the two professions? The architect must apply engineering theory and practice to the selection and placement of suitable materials to resist imposed loads, otherwise our magnificent architectural creations could not be constructed. The arcihtect is more of an artist than an engineer, since his work is made to appeal to the eye. The engineer could rightfully say that when the architect uses construction materials to sustain the artistic creation the architect is usurping the place of the engineer.

In reality, the architect needs the engineer to sustain his structures. The engineer needs the architect to dress up his structures so that they may meet the requirements of suitable expression and harmony. The engineer has done some terrible floundering in the attempt to dress up structures architecturally.

What we need is more cooperation of the two professions and a discontinuance of attempts to separate them.

Will man never learn that cooperation leads to community benefit, and that individualism leads to destruction? Is it not high time to begin eliminating the intensive greed for individual gain and to place more concentration upon efforts to benefit civilization?

There is much work to be done. Is the greed for money still the criterion for not doing it? ALBERT H. MYERS.
Milwaukee, Wis.,
March 31, 1933.

A Simple Test for Soil Stability

Sir—Very few projects where a knowledge of soil properties is important can afford the time or expense of establishing the complicated laboratory equipment necessary to determine all the properties that have been investigated in soil researches. Size, grading, percentages and shape of particle determination, involving delicate screening, weighing and lutriation apparatus, and electrophotomicrography is hardly to be classed as field equipment for an engineer or contractor. When colloidal or hydrogen ion effects enter into the problem it becomes still more complicated by the inclusion of a practically complete chemical and physical laboratory.

In checking over some of the laboratory test results as outlined in paper 1,689, p. 1,415, *Trans.*, Am.Soc.C.E., by R. E. Miller, some interesting relations between the items were noted that had apparently been overlooked before. These give promise of the beginnings of such a simple method of classification of all kinds of soils as has been desired for some time. Put in its simplest form, the commonest and major question that the engineer wants answered in connection with a soil is this: What will be its characteristics and behavior when in contact or saturated with water?

In one part of the laboratory method mentioned above the percentage of moisture that the material holds when in the plastic stage (definitely determined by the asphalt pentetrometer method) is determined. In another the percentage of moisture that the given soil will absorb under a fixed condition is very simply and easily obtained. Now it may be logically concluded that, if a material will absorb by capillarity a larger amount of water than it takes to make it plastic, such material will always have a natural tendency to become more or less fluid whenever subjected to the action or contact of large quantities of water. Following up this train of thought through the test results from a wide variety of samples, a definite mathematical relation was established by dividing the percentage of moisture by capillarity by that at the plastic stage, and tentatively giving this figure the designation index of fluidity.

Interesting results soon became apparent as some samples gave indices near unity (1), while others were as high as 2.21, which meant that the latter if in contact with water would absorb more than twice as much as necessary to make it plastic, i.e., would become liquid. Checking up on these soils through the other laboratory tests and their behavior in the field has confirmed very strongly the value of this index in judging different earths. Its best feature is that it cancels out the unknowns in the soil sample problems, such as particle size, shape, grading and percentage, and effects of colloids, which after all are of only academic interest to the engineer; and it answers by a simple number the question of exact rank of any given material in the scale of utility for various purposes.

Considerable corollary data on samples from widely separated fields in North America are available in connection with the method suggested here if the profession should be interested in this germ of an idea. Extension of its use in many directions, such as dam, or roadbuilding, levee materials, bearing power of soils for all kinds of structures, in piledriving, etc., can be visualized. It is realized that a good deal of laboratory research work should be done to determine its ultimate form and accuracy, but the fundamental idea seems logical and is very simple to use.

B. G. FLAHERTY,
General Dredging Contractors, Ltd.
Montreal, Canada,
Jan. 17, 1933.

Engineering News-Record

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Needed Competition

GOVERNOR LEHMAN, of New York, recently vetoed a bill requiring that all material used on state work be manufactured in the United States, stating in his veto message that the principal effect of the bill would be to increase the cost of work done in the state and that the object of the bill was being attained substantially at the present time without the burdensome restrictions of mandatory legislation. This bill is but one of many of a similar nature that have been urged upon and sometimes passed by state legislatures in the last three years, many of which went so far as to restrict purchases to state products whenever available, while others required that contractors on state work must have an established place of business within the state. All such legislation expresses a form of provincialism which, as Governor Lehman states, has little practical result other than to increase the cost of the work in hand. Foreign goods seldom displace domestic construction materials, but they represent needed competition. So also in contract operations the local man has a natural advantage over the outsider in familiarity with local conditions, material prices and labor market; but knowledge that outside contractors may be bidding on the work forces him to make the most of that familiarity in his bidding and results in close calculations from which the public benefits. These are sound and proper competitive conditions; they should be fostered, not eliminated.

Deflation and Expansion

FOLLOWING immediately on the sensational gold-export embargo of the 19th and the resulting wild outburst of inflationary speculation, a tendency appeared in many quarters to believe that the fundamental problem of unemployment could now be forgotten. Such beliefs are probably fairly well dissipated by now. If not, it need only be recalled that the steps taken by the new government during the last six weeks, necessary as they were, had an essentially deflationary effect, and that a heavy drop in wage earnings—as large as 10 per cent—was recorded for March. In the light of these facts the necessity for active expansion of enterprise and activity is more obvious than before. The twelve to fifteen million idle workers still wait for the jobs on which their livelihood depends, and merchants and manufacturers wait for the orders that must come from the wages of these workers before they themselves can resume business. Some large purchases of commodities were made during the upswing of prices last week; but aside from their effect on prices, mere changes of ownership accomplished nothing for industry and cannot well do so until the ultimate consumer resumes ordering. In short, nothing has yet altered the necessity for early attack on the basic problem of starting up public-works construction through a broad national movement. If anything, the matter is more urgent now than it was two months ago, since the farmer's prospective gain through higher prices for foodstuffs cannot be paid for by the workers until they are again on the wage payroll. In the meantime, the embargo order paves the way to reconstruction. The country gains the great advantage of having its money and credit safeguarded against the operations of exchange speculators, which places industry and business in a position to maintain a sound structure of values. Further, by establishing the national credit as the base of our financial system it gives new assurance to investment. Direct action for business revival through public-works employment is the logical next step.

Cement Improvement

A QUARTER CENTURY'S accomplishment in cement development, as set forth by two groups of figures which we published last week, represents a noteworthy industrial achievement. Continued efforts on the part of manufacturers in response to growing demands by users produced successively higher strength, so that cement today is half again as strong as that of pre-war years. Doubt has been expressed, however, as to whether the high content of tricalcium silicate responsible for much of the strength increase does not involve a sacrifice of other qualities, among them durability, volume constancy and resistance to corrosion. It will be remembered that special cement low in tricalcium silicate has recently been developed for massive dam construction, with a view to reduced heat generation; but this is a special requirement which probably has no meaning with respect to ordinary service. A more pertinent matter is the claim that high tricalcium silicate is unfavorable to long life. Experience records are as yet too short to dispose of this question, but an interesting bit of testimony cited by P. H. Bates in connection with his records of composition deserves to be noted. He reports that several important structures forty or fifty years old contain large amounts of cement high in tricalcium silicate. Obviously, additional evidence of the kind would make out a strong case against the claim that this constituent reduces durability. This in turn would tend to show that the trend of advance in cement improvement has by no means been in the wrong direction. This and many other questions about cement are still deeply involved in ignorance, but the intensive study now going on should enlarge our knowledge greatly in the early future.

Prices and Bidding

REFERENCE to cement calls to mind the sorry financial statements reported by cement-manufacturing concerns for the last two years, due to selling below cost in a campaign of ruinous competition. We have repeatedly expressed the belief that prices of materials, cement included, should be brought up to cost level or higher, if necessary by Federal Trade Commission pressure, on the ground that business done at losing prices threatens everybody's solvency, including that of governments and the public. Carrying this thought farther, we urged some weeks ago (*ENR*, Feb. 9, 1933, p. 201) that public officials should make it their public duty to support a fair price structure, and that when they reject bids merely to beat down prices they are acting against

good public policy. The Governor of Illinois appears to hold a different view, for he has three times rejected bids for cement and now threatens to build or lease a state cement plant in order to bring prices down. The prices that he rejected are well above those paid by the state a year ago, but in view of the facts this must be considered a constructive development rather than the opposite. If the present prices are excessive, this can doubtless be brought to light more effectively by a cost audit than by fantastic threats or official bid shopping. The very structure of public business rests on the system of competitive bidding, and that form of bid shopping which utilizes rejection of bids as a device for forcing down prices is therefore fundamentally reprehensible. It operates to destroy the vital essential of efficient contracting.

Checking Bid Chiseling

THE EVIL PRACTICE of bid shopping, more appropriately called bid chiseling, has grown by leaps and bounds in the fertile field of a depression-ridden construction industry. It permeates the entire industry. No one element, from the circle of architects and engineers to that of labor, is free of its influence. Sporadic attempts have been made to better the situation, especially by subcontractor organizations, but such attempts had little effect, the more so because individual subcontractors themselves defeated the movement by asking general contractors for a chance to revise their bids downward. Congress has recognized the importance of the situation in its relation to federal construction, but as yet no remedial legislation has been enacted.

Sentiment in the industry is against bid chiseling. Of this there can be no doubt, for the practice is known to bring loss to all. Intelligent and responsible firms uniformly oppose the practice, but they are powerless in the face of their competitors' attitude. Despite the prevailing sentiment, therefore, the evil is deeply rooted and cannot be stamped out by any one individual or group or by any action from within. The construction industry's many components lack the strength of adequate organization necessary to make headway against it.

There is one course open, however—namely, to utilize the aid of an interested outside agency, impartial and unbiased, but so situated as to be able to bring pressure to bear upon offenders. This agency is the Bureau of Contract Information, now well established as counselor to bonding companies, awarding authorities and contractors. The bureau has the respect and confidence of the public and the industry alike, and by virtue of this position and its necessarily close relation to surety bonding it is in a position to exert a powerful influence against bid chiseling.

An example of its influence is a case that occurred only a few weeks ago. A subcontractor had been forced down to an impossible price by the general contractor, who himself had obtained the contract by cutting his bid to a losing figure in the expectation of forcing his subcontractors to absorb the cut. But upon discovery of the conditions by the bureau and disclosure of the facts to the bonding companies the subcontractor was refused a bond, which forced the general contractor to use a higher sub-bid. As a result, the general contractor had to stand the loss that he himself invited.

General application of this same method can check bid chiseling and so help to correct the present bad situation. But if the method is to be widely effective, suitable enlargement of the bureau's operations must be made. In their own interest as well as for the good of the industry, all who are dependent upon construction should give the bureau their cooperation and financial support.

Better Codes for Better Building

DURING the past seven or eight years building-code revision has been more active than for a decade previously. The great increase in urban building made this inevitable, for the old codes were out of date and inadequate. One of their greatest shortcomings was that they were so drawn up as to be incapable of easy change, and many of them followed the now-discredited pattern of detailed specification, which accentuated the effect of their inflexibility.

Poor practices not only could not be changed under the old codes but, being part of the ordinance itself, they therefore were mandatory. In the old codes and unfortunately in some of the revised ones, the essential purpose of a code, which actually is to assure safe building, has mistakenly been assumed to be that of guaranteeing good building by making bad building illegal. Such codes set a minimum below which bad building cannot go, but they can have no effect to improve building.

Inflexibility on the one hand and detailed specification on the other have been the cardinal sins of building codes. The fact that the proposed new code for New York City goes a long way towards renouncing them augurs much for building development. Whether the New York code is adopted or not—and it plainly now is at the mercy of the political winds and the Board of Aldermen—it is a model that might well be widely emulated. It no doubt contains defects; Rudolph P. Miller in his two articles, which are concluded in this issue, points out some of them. But it accomplishes the patent necessities of reducing detailed specification to a minimum, of providing for flexibility and of transferring the responsibility for improving building practice to the architect and the engineer.

The code itself is brief and fundamental, prescribing only those requirements that are necessary for safe construction. Building standards and practices, such as loads and stresses, methods of design, etc., are given the status of rules and are easily subject to change or amendment, thus securing the required flexibility. Finally, and perhaps most important, the engineer or architect not only must sign his plans when applying for a building permit but he must accompany his request for a certificate of occupancy by an affidavit stating that the structure has been erected according to the approved plans. Good building thus is encouraged, for an affidavit on a poor structure will hardly enhance an engineer's or architect's standing. The responsibility is placed where it belongs, and incidentally where reputable engineers and architects want it—namely, on their own shoulders.

Good building is always needed. That it has an importance for the community as well as the individual was recently emphasized by the Long Beach earthquake. Building codes alone cannot guarantee safe building. They cannot assure good or efficient building above a certain minimum—always too low to guarantee against every mischance. But if properly framed and enforced, they will not be a hindrance to good building as they often have been in the past. Better building codes are being framed today than ever before, and the proposed new code for New York City is among the best.

NEWS OF THE WEEK

Loans of $1,134,050 Approved by R.F.C. For Eight Projects

LOANS totaling $1,134,050 for eight self-liquidating construction projects and a ninth loan of self-liquidating character but involving no construction, were approved by the directors of the Reconstruction Finance Corp. on April 20.

The principal loan authorized was $650,000 to the West Michigan Dock & Market Corp. "when and if it is organized," to aid in financing construction of wharves, transit sheds, a combined office and passenger station building and a public market with appurtenant facilities at Muskegon, Mich.; $426,000 is expected to be spent for materials.

The other loans authorized were $37,500 to the town of Springer, N. M., for the modernization of the town's water system; $40,000 to the village of Crestline, Crawford County, Ohio, for a covered concrete storage reservoir, water chlorinating apparatus and the necessary piping; $300,000 to Michigan City, Ind., for the construction of a filtration plant and elevated storage tank, for new pumping equipment and for replacing distribution mains; $13,250 to the town of Commerce, Texas, for a new water supply well and pump and storage facilities; $67,000 to the board of trustees of Arkansas Polytechnic College, Russelville, Ark., for remodeling three dormitories and adding connecting wings; $6,300 to Santa Clara, Utah, for a new water supply pipe line, and $20,000 to Woodville, Tyler County, Texas, for a new sanitary sewer system and waterworks, including a deep well and pumping plant.

The Reconstruction Finance Corp. also agreed to loan $250,000 to the city of Berlin, N. H., for the employment of 800 men in cutting wood, part of which is to be used for fuel and the rest sold for pulpmaking purposes. The loan is considered to be self-liquidating, as the city expects to realize enough from the sale of the wood to repay the loan. The R.F.C. agreed to purchase one-year tax anticipation warrants bearing 4½ per cent interest. Under a statute recently enacted, these warrants will be guaranteed by the state of New Hampshire.

Metropolitan Sewerage District Planned in Rhode Island

Under the provisions of a bill passed by the Rhode Island General Assembly, the Governor is to appoint a special metropolitan commission to consider the establishment of a sewerage system to serve Central Falls, Pawtucket, Providence, Cranston and Warwick with a trunk outfall sewer extending into the Atlantic Ocean. It is planned to apply to the R.F.C. for a loan.

Surveys Begun for Reservoir on Cove Creek in Tennessee

As a preliminary to the proposed development of new power sites in the Tennessee River valley, the Secretary of War has allotted $60,000 to the district engineer at Chattanooga for a survey of the properties to be overflowed by the proposed reservoir behind the Cove Creek dam on the Clinch River, a tributary of the Tennessee. The survey parties will determine the flow line and the areas and boundaries of each parcel of land required for the reservoir. The area comprises nearly 60,000 acres.

It is proposed to have the district engineer place not less than thirty surveying parties in the field at once.

Dwelling Law Change Approved

An amendment to section 300 of the multiple dwelling law of New York State, the section which was the source of a long controversy between architects and engineers of the state in the years 1929-32, has been approved by the Governor.

As passed in 1929, the section of the act relating to the filing of plans for multiple dwellings (section 300) stated that plans for such buildings were to be filed and affidavits sworn to by the owner or a registered architect acting as his agent. The effect of this wording, as soon as architects had made an issue of it with building departments in New York City (the only city where the law is in effect), was to prevent engineers from filing plans even for changes in mechanical equipment of apartment houses. As now amended the words "or a licensed professional engineer" have been added after the word architect.

New Chief Engineer of Louisiana Highway Department

W. H. Norckauer, engineer in charge of federal-aid highway work in Louisiana, has been made state highway engineer, effective April 30, to succeed Harry B. Henderlite. Mr. Henderlite resigned along with C. V. Baker, assistant highway engineer; H. W. Holmes, consulting engineer; E. H. Kivett, physical testing engineer, and C. H. Garriss, chief draftsman. The resignations were voluntary, according to chairman A. P. Tugwell of the highway commission, and were handed to the commission in order to facilitate its consolidation and economy program. The new highway engineer will receive a salary of $4,800 a year as compared with the $6,000 paid Mr. Henderlite, and other salaries will be correspondingly reduced.

Mr. Henderlite has been with the highway department since 1929 and Mr. Norckauer has been with the department 22 years. He served as state highway engineer in 1929.

Water Works Groups Hold Joint Meeting at Rockford, Ill.

IN a joint two-day meeting of three waterworks associations at Rockford, Ill., April 20-21, current operating problems, economic topics and some notable changes in organization set-up were handled. Officially the meeting was the annual spring convention of the Illinois section of the American Water Works Association with the Central and Southern Illinois Conference of Water Treatment Plant Operators and the West Shore Water Producers Association participating as guests.

A new constitution formed after the model laid down for sections by the parent association was submitted to the Illinois section of the A.W.W.A. by a committee on scope and policy, together with an analysis of the section's past activities. A spirited debate ensued revolving around the lack of growth and small attendance of plant superintendents (20 to 25) at recent meetings. There are 549 waterworks in the state. The Illinois section has a large membership from the Chicago metropolitan district, but quite a sparse representation from down state. In consequence its position as fifth largest of the A.W.W.A. sections does not mean it is serving the state as a whole as well as it might. Despite the slim record of attendance of the superintendents, the manufacturers have stood by the section, their representatives often making up one-third of the attendance at conventions. The new constitution and the new activities proposed are designed to obtain a better cross section of the section on the executive committee, and better cooperation with the visiting organizations, if not affiliation. Both have a better record of serving plant operators than has the section.

Legislation approved

Proposed laws calling for certification after examination of treatment plant operators were indorsed, also the bills now in the legislature authorizing sewage service charges and use of these funds to obtain R.F.C. funds. In the technical program construction, design and treatment were stressed, as well as operation.

How to combat certain foolish beliefs relating to chlorine and chemical treatment was outlined in a paper by C. W. Classen, assistant engineer, Illinois State Board of Health. Some of these beliefs noted are that an iron-bearing water is good for the blood, that a sulphurous water has medicinal properties, and that hard water promotes the use of soap, hence cleanliness. Soft water advocates were given the consoling information that one glass of milk is equal in lime content to 65 glasses of Rockford water.

Emergencies, said Arthur E. Gorman, filtration engineer, Chicago water department, can best be prepared for by a careful

survey to uncover weak spots, followed by drills in repair procedure.

F. C. Amsbury, Jr., detailed his experiences in the use of ammonia-chlorine pretreatment of the Champaign-Urbana supply to free the filter beds of iron bacteria.

False economies in filter plants

Average unit costs of a combined pumping station and filtration plant were given by George B. Prindle, Highland Park. Of a total of $40.30 per million gallons for operating costs, 49.6 per cent goes for superintendence and labor; 33.4 per cent for pumpage; 12 per cent for purification costs and 5 per cent for heating, etc. One of the most frequently practiced false economies is in the use of wash water. As washing costs but 0.7 per cent of the total, attempted economies here are foolish. They never can exceed 1 per cent of the water bill and may result in unsatisfactory water.

Louisville, Ky., recently has completed a high service reservoir and 8 miles of 48 and 60-in. reinforced concrete pipe. Charles B. Burdick, consulting engineer, Chicago, told how the reservoir had increased the capacity of the pumps and distribution arteries by 50 per cent. This 30-m.g. reservoir was built as a monolith, and is so tight that the average leakage for 6 days is but 0.031 in. per 24 hours. Specification for the pipe lines allowed 100 gal. per mile per inch per day leakage, but tests showed only 27.8 gal.

The newly elected officers of the section are as follows: Chairman, J. J. Wolfman; vice-chairman, L. I. Birdsall; A. E. Skinner to succeed the late H. E. Keeler, and W. R. Gelston, directors of the national organization.

Bridge Legislation Approved by New York State Governor

Two bills passed by the New York State Legislature before its adjournment making provision for possible construction of important bridges have been approved by the Governor. One bill creates the Thousand Island Bridge Authority, a "body corporate and politic constituting a public benefit corporation," and authorizes it to cooperate with any Canadian agency in the construction, maintenance and operation of bridges and incidental roads across the St. Lawrence River from the New York mainland to the Canadian mainland by way of Wellesley or Wells Island in Jefferson County, New York, and Hill or LaRue Island in the Province of Ontario. The bridge authority is authorized to issue bonds and provide for their repayment and for the maintenance and operation of the bridge through tolls.

The second bill authorizes the construction of a new bridge across Lake Champlain through an amendment to the agreement between New York and Vermont creating the Lake Champlain Bridge Commission. The commission is authorized to construct a bridge or bridges across Lake Champlain between points not more than 52 miles north of its present bridge at Chimney Point, but requires that one bridge be built at or near Rouses Point.

Other bridge bills already approved by the Governor of New York State are one creating the Triborough Bridge Authority of the City of New York for the purpose of financing the completion of the Triborough Bridge, and an amendment to the act of 1929 creating the Niagara Frontier Bridge Commission in order that it could borrow money from the Reconstruction Finance Corportation for the construction of the Grand Island bridges.

Washington Notes

By Paul Wooton
Washington Correspondent

Locations for 749 forest conservation camps which have been approved include 645 in the national forests, 50 in national parks and 54 state camps in Pennsylvania. No agreement for cooperative work has been reached with other states to date. It is understood that the arrangement with Governor Pinchot provides that he will request the legislature to authorize reimbursing the federal government for the actual man-hours of work put in state forest and game lands on the basis of the $1 a day wage.

The same proposal may be made to other states as no response was received to the original proposition that state land purchased by the federal government in the first instance at $1.50 an acre should be bought back by the state at a later date on an appraisal of its improved value but at a price not to exceed $3 an acre. No arrangements have been made for work on private land and Robert Fechner, chief of the emergency conservation work, has explained that no work is likely to be undertaken on land which the private owner will not carry on after the government's activity ceases. Spreading the work to include state, municipal and private land would put more men to work in the east where the federal camps so far approved number only 107.

Maj. R. Y. Stuart, chief forester, and Maj. Gen. Lytle Brown, chief of the Army Engineer Corps, have agreed that the work program embraces flood prevention only to a rudimentary extent, such as tree planting to check soil erosion. The work will not include construction of levees or dams for the storage of water, rectification of streams or building of outlets.

Snow Ends Threat of Drought

Deep snow over much of Colorado, Wyoming and Nebraska, while causing serious inconvenience to highway traffic, has ended the threat of drought which has hung over Denver and the surrounding communities since early spring, when lack of rain made it appear that there would be a serious shortage of water this summer. From 8 in. to 3 ft. of snow fell over the South Park area, where Denver gets its water supply.

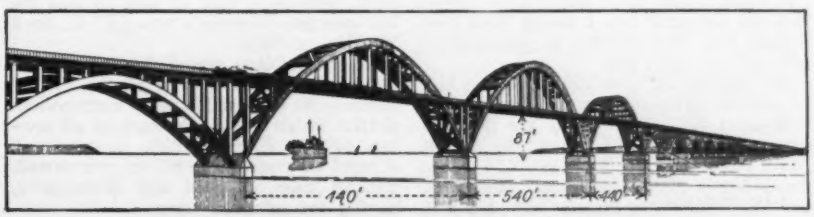
Floods in New England Rivers

Due to a rainfall during the first two weeks of April in excess of twice the normal monthly rainfall, most of the rivers in New England were in flood last week. In many places the crest of the flood was reported to be within a few feet of the height reached in the disastrous flood of 1927, but no major increases were expected, due to the change of weather that occurred over the week-end. In Boston, up to April 18, 6.88 in. of rain had fallen, as against a normal of 3.34 for the entire month.

Fraser River Bridge Proposed

The Ladner Bridge Co., Ladner, British Columbia, proposes to build a bridge, 1,117 ft. long across the Fraser River at that point. The bridge approaches are to be of timber construction and the main river spans of steel, including a 300 ft. lift span with a clearance of 160 ft. when open.

Legislative approval has been given to the project, the Provincial Government stipulating the terms under which it will enter into an agreement with the Ladner Bridge Co. The new span, it is stated, would be erected by Dorman Long and Company, of London, England. The cost of the new bridge is estimated at $2,600,000 and two years will be required for its construction. The proposed structure, on which it is intended to charge tolls, would provide an important traffic connection between Vancouver and the international boundary, bringing the Pacific Highway into the city by a shorter route than the present one.



START TO BE MADE ON NEW DANISH BRIDGE

Arrangements were being made by Dorman Long & Co., London, England, to start work on April 15 on the construction of the new steel railway and highway bridge, known as the Storstrommen bridge, between the islands of Falster and Zeeland for the Danish Government. The contract for the bridge was placed provisionally last year (ENR July 14, 1932, p. 61) but a start has been held up pending arrangements to finance the project which is estimated to cost two million pounds ($6,900,000). It is now stated that the Bank of England is to furnish a credit of one million pounds and that the remainder will be supplied from the new Danish gasoline tax.

The new bridge will be two miles long and will connect Orehoved and Masnedo. It will consist of a series of two-hinged arches the approaches to be of deck type with spans ranging from 152 ft. near the coast line to 266 ft. toward the center of the channel. The three channel spans will be through arches 440, 540 and 442 ft., long. Shipping clearance at the center is 85 ft., maximum depth of water 50 ft.

Irrigation in Chihuahua, Mexico

As the result of arrangements made with the federal government, the Chihuahua state government will have 1,000,000 pesos available immediately to execute irrigation works chiefly for 35,000 acres of land for cotton planting, in the Juarez Valley near Chihuahua City. Costs of the work will be shared equally by the two governments, and the undertaking will be directed by engineers of the National Irrigation Commission.

Legislation Affecting Engineers Approved in New York State

Two bills amending the education law of New York State relating to the practice of professional engineering and land surveying and one bill relating to the practice of architecture, passed by the recent session of the legislature, have been approved by the Governor. The most significant change, included in both the architects and engineers law, is a provision that all applicants must pass a written examination to establish their competency to plan, structurally design and supervise the construction of buildings and similar structures. Heretofore both laws permitted the licensing board to exempt graduates of recognized engineering and architectural schools from such examinations up to the year 1937. Another change modifies the exemption for buildings costing $10,000 or less in both laws by adding a clause which states that the law does not apply to structures "not exceeding 30,000 cu.ft. nor to alterations to any building or structure costing $10,000 or less which do not involve changes affecting the structural safety thereof."

Bids Called for More Tunnels of Colorado River Aqueduct

The Metropolitan Water District of Southern California is calling for bids to be opened May 22 on four of the tunnels for the Colorado River aqueduct. Those included in the May 22 call are East Eagle Mountain, 1.79 miles; West Eagle Mountain, 4.98 miles; Hayfield No. 1, 1.82 miles; Hayfield No. 2, 1.02 miles, and three Mecca Pass tunnels with a total length of 1.1 miles. The West Eagle Pass tunnel and the Hayfield No. 1 tunnel have been divided into two sections to permit separate bids on each end.

On June 12 the district will receive bids on another group of tunnels, estimated to cost about $5,000,000. They are the Colorado River tunnel, 1.07 miles; the Copper Basin No. 1 and No. 2 tunnels, 2.34 miles; the Whipple Mountain tunnel, 6.09 miles, and the Whitewater tunnels Nos. 1 and 2, 1.90 miles. To facilitate bidding, the Copper Basin No. 2 tunnel has been divided into two sections, and the Whipple Mountain tunnel has been divided into three, an east portion of 1.89 miles, a central portion of 3.18 miles and a west portion of 1.02 miles.

Alternate bids for a finished interior diameter of 16 ft. and 12 ft. 4 in. are being called by the engineers of the water district. Contracts let to date have been for the larger diameter.

Sewerage District Set Up for St. Paul and Minneapolis

AS a last-minute act the 1933 Minnesota legislature before adjournment passed the metropolitan drainage bill creating a Sanitary District of St. Paul and Minneapolis for a sewage disposal plant. Governor Olson signed the act at 1 a.m. April 19.

The act provides that the sanitary district will be governed by a board of trustees. The city councils of St. Paul and Minneapolis each will elect one councilman as a trustee and one other trustee from each of the cities or counties, the mayor of each city will also be a trustee, or he may delegate this authority to some other official of the city, and the Governor appoints one member representing the state. The Governor's appointee will receive $1,000 annually; other trustees $10 per meeting, not to exceed $600 in any one year.

Trustees have the power to appoint a secretary, a chief engineer and other consultants. All skilled or unskilled labor is to be employed at the prevailing wage scale in effect in the city in which the work is performed. The state treasurer becomes the treasurer of the sanitary district.

Board of Health to act

The plan for sewage disposal will be put in motion by the State Board of Health declaring for an abatement of the sewage situation of the Twin Cities and by written order declaring the two cities to be a Sanitary District. The trustees of the district must then be appointed within 60 days after the order of the State Board of Health.

The estimated cost is $16,000,000, based on the use of Pigs Eye Lake Island, lying in a widening of the Mississippi River Valley near the south limits of the city of St. Paul, for the disposal plant.

Bonds will be issued by the sanitary district trustees over a long-term period to finance the project.

Subject discussed many years

Signing of this bill by the Governor disposes of a subject that has involved the two cities for several years. A metropolitan drainage bill was vetoed two years ago by Governor Olson and the legislature failed because of lack of time to pass the bill over the Governor's veto (*ENR*, April 30, 1931, p. 743).

Governor Olson vetoed this bill because it was not in the interest of the city of Minneapolis and established a metropolitan district which would take care of all sewage of the district which in any way affected the river. The bill, as now passed, involves only St. Paul and Minneapolis, leaving out suburban towns.

Financing plan

The cost of operation, maintenance and of all treatment and disposal works will be financed on the basis of the assessed valuation of the two cities. This will be effective for ten years, after which the sanitary district will allocate costs of maintenance on a volume-meter basis for each city. The bill provides that the city of South St. Paul may be added to the district later if the two cities permit.

Rio Grande Treaty Ratified

On April 25 the U. S. Senate ratified the treaty with Mexico which provides for straightening and regulating the Rio Grande in the El Paso region (*ENR*, Feb. 16, 1933, p. 226). The cost of the work, about $6,000,000, is to be borne by both countries.

Resumption of Home Building To Be Discussed in Chicago

A national conference on the renewal of home building is to be held at the Congress Hotel in Chicago, May 9-10. It has been organized by J. Soule Warterfield, vice president of the Starrett Building Co., Edward J. Mehren, president, Portland Cement Association, former editor of *Engineering News-Record;* Daniel H. Burnham, chairman, Chicago Regional Planning Commission; N. Max Dunning, housing adviser to the R.F.C.; Henry A. Guthrie, Millar's Housing Letter, and officers of various building industry trade associations and building supply firms.

The proponents of the conference believe that home building is being retarded not only by the business depression but also by a widespread impression that important changes in building technique are pending which will make present methods obsolete.

Speakers include James S. Taylor, chief of the division of buildings and housing, U. S. Department of Commerce and Louis Brownlow of the Illinois Housing Commission.

Collapse of Breakwater Caisson Brings Design Change Proposal

Recommendation that the city of Santa Monica, Calif., abandon its plans for construction of a concrete caisson type of breakwater for its proposed pleasure yacht harbor has been made by D. E. Hughes, engaged as a consultant by the city and the contractors after the first of the series of concrete cribs had cracked. The crack developed after the first unit had been sunk in its approximate final position. Scouring action of currents was blamed for the cracking, which was followed by the virtually complete wrecking of the unit by action of the sea. Mr. Hughes, who was in charge of building of the original San Pedro, Calif., breakwater, recommended that Santa Monica construct a rock mound type of breakwater. His recommendation has been opposed by Taggart Aston, engineer, and others, who declare the city's plans should not be changed because of the present difficulties. They assert the first crib was wrecked because it was placed on the sands of the ocean floor, easily scoured by currents, and not on a foundation of rock, laid on clay beneath the sand. The crack developed, it was reported, when strong currents scoured a trough on each side of the crib, allowing it to settle at one end.

The Puget Sound Bridge and Dredging Company and W. F. Way, Inc., have the contract for construction of the $690,000 breakwater project.

Regional Planning Produces Results in New York Region

EXPERIENCE with the application of the regional plan for the New York vicinity, completed four years ago, was reported at a meeting of the Regional Plan Association on April 25. Much of the physical improvement in the region covered by the plan has been carried out in accordance with the plan, it was stated. The various governmental authorities in most instances fitted their projects closely to the lines of development laid down by the general plan.

Certain important missing links in the development of the major parts of the plan were listed by Harold M. Lewis, engineer of the association, as public works projects of urgent character that should have immediate attention. Among these are the completion of the Triborough bridge and of two state highways in the New Jersey suburban region, parts of routes No. 1 and No. 2. Other major highway projects, several railway improvements and parks and parkways are included. Most of these are for immediate service needs, but some are demanded for conservation of existing values, as the construction of a parkway in the Christie-Forsythe St. area, acquired and cleared by the city some years ago for a future housing development, and the East River Drive from Grand to 14th Sts.

Of the major highway routes laid down in the plan not less than 550 miles have been built or are in process of construction, representing one-fifth of the mileage of the major routes in the plan. Parkway mileage has been practically doubled in the four years. About 100 miles of express highway have been built or are under construction, as compared with 3½ miles existing four years ago.

Willard T. Chevalier, publishing director of *Engineering News-Record*, outlined reasons why public works expenditure is especially justified at this time and showed that regional planning is necessary to make such expenditure most efficient. Thomas S. Adams, former director of the regional plan referred to the fact that programs of public works have been found essential in various countries abroad.

George McAneny, president and director of the association and recently inaugurated as sanitation commissioner of New York City, stated he will continue as president of the association. He remarked that there has never been so great a need for a sound program of works, in view of the vast sums being spent for relief and the intimate relation of public works to economic recovery, and that proper direction of such a program by planning is vital to its success.

Municipal Service Reorganized

The cooperative service to public officials, research agencies and others interested in government, heretofore conducted under the name of Municipal Administration Service, has been reorganized under the name of Public Administration Service with headquarters at 850 East 58th St., Chicago, where it will have the benefit of the facilities of the "Chicago Group" of secretariats of associations in the government research.

Bridge Proposed at Vancouver

Construction of a bridge over First Narrows at Vancouver to give better access to West Vancouver has been proposed to the city council by responsible parties interested in the development of West Vancouver. The bridge will have a suspended span 1,500 ft. long over Lions Gate and an underclearance of 200 ft. The cost is estimated at $6,000,000.

Preliminary plans for the bridge have been prepared by Monsarrat and Pratley, consulting engineers, Montreal. Private financing is proposed and public approval is urged at this time in order that the bridge may be built as a means of creating work.

SOCIETY CALENDAR

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Chicago, June 27-30.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Chicago, June 26-30.

AMERICAN WATER WORKS ASSOCIATION, annual meeting, Chicago, June 12-16.

AMERICAN WELDING SOCIETY, annual meeting, New York, N. Y., April 27-28.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual convention, Chicago, June 26-28, 1933.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting, Chicago, June 27-30.

ENGINEERS WEEK, Century of Progress Exposition, Chicago, June 25-30.

DETROIT ENGINEERING SOCIETY will hold its 39th annual meeting on May 4. At the dinner C. F. Kettering will speak on his studies of ancient civilization in Mexico.

NEW YORK SECTION, American Water Works Association, has abandoned its plan to hold a spring meeting on account of the nearness of the annual meeting of the association in Chicago and will hold its meeting in the fall at a date to be announced.

MID-SOUTH SECTION, American Society of Civil Engineers, will devote the two days of its annual meeting at Vicksburg, Miss., May 5-6, to Mississippi River problems. Major General Lytle Brown, Chief of Engineers, U. S. Army, will be the principal speaker at the banquet on May 5. Special demonstrations for the party will be given at the U. S. Waterways Experiment Station at Vicksburg on May 5, and on May 6 the party will visit the Diamond Point cut-off, the first major cut-off to be made in the river for nearly 100 years.

Personal Notes

JOHN E. MEADE has been appointed deputy chief engineer of Providence, R. I.

WALTER R. KENDRICK has been appointed superintendent of sewers, Providence, R. I. Mr. Kendrick has been with the department for about 30 years.

FRANK G. MCDEVITT, consulting engineer, has been appointed director of streets and sewers in St. Louis. He is the third engineer to be appointed by the new mayor to head important divisions of the city's operation.

S. F. WILSON has been appointed district engineer of the Illinois Division of Highways with headquarters at East St. Louis to succeed CHARLES M. SLAYMAKER who has been transferred to Springfield as district engineer. K. M. EVANS, district engineer at Springfield, becomes maintenance engineer of the East St. Louis district.

ABNER R. BERGENSEN, formerly a contractor at Tacoma, Wash., has been appointed commissioner of public works there.

JOHN W. DONOHUE, construction engineer, Syracuse, N. Y., has joined the firm of Daniel D. Pomeroy of that city to take charge of the property managing department.

MURRAY D. VAN WAGONER, drain commissioner, Oakland County, Mich., and formerly in private civil engineering practice in Pontiac, Mich., has been elected state highway commissioner of Michigan to succeed Grover C. Dillman. Mr. Van Wagoner is a civil engineering graduate of the University of Michigan and after graduation served three and one half years in the state highway department.

DANIEL W. MEAD AND CHARLES V. SEASTONE have turned over their consulting engineering practice to HAROLD W. MEAD, CLAYTON N. WARD and HENRY J. HUNT, former associates with them, who will continue the business under the firm name of Mead, Ward & Hunt, with Clayton N. Ward as chief engineer. Offices will continue at Madison, Wis. Daniel W. Mead and Mr. Seastone will continue their association with the new firm in an advisory capacity.

Obituary

M. SCHURMAN, prominent building contractor of Canada, died at Toronto, Ont., recently, age 80 years.

EUGENE WRIGHT, civil engineer of the Valuation Department of the Interstate Commerce Commission, died at his home in Philadelphia April 12, age 42 years.

WALTER W. KERCH, city engineer, Granite City, Ill., died there on April 13, age 49 years. Mr. Kerch was a graduate of the University of Illinois. He had been in ill health for several months.

WALTER GOODENOUGH, consulting engineer, New York, died there on April 24, age 58 years. Mr. Goodenough is best known in the civil engineering field for his work in connection with the construction of the ship yards at Hog Island in the Deleware River at Philadelphia. In recent years Mr. Goodenough was associated with Dwight P. Robinson, New York, and with Stone & Webster at Boston.

JOSEPH H. WILLARD, colonel, Corps of Engineers, retired, died at his home in Newport, R. I., April 16, age 89 years. Colonel Willard is a native of Chicago, and was educated at West Point, graduating in the class of 1868. For a long period after the Civil War he was on Mississippi River work and again, in 1883 he returned to Vicksburg for 13 years of service on the river. He retired from the army in 1907 but was recalled to service during the World War and stationed at Newport.

Brief News

FOR THE CONSTRUCTION OF A FOREST-TYPE ROAD over the Black Range, Grant and Sierra Counties, New Mexico, have pledged $90,000 and the State Highway Commission has been asked to match the pledge the amount of the two counties. It is estimated that the road can be built for $10,000 a mile.

EXPENDITURE OF UP TO $10,000,000 on highway work has been authorized by the state of New York to match federal funds in emergency construction work on the federal-aid highway systems if and when Congress appropriates money for that purpose.

SALE OF THE AZUSA HYDRO-ELECTRIC PLANT of the Southern California Edison Co., to the city of Pasadena, Calif., together with 1,000 acres of land lying within the Pasadena Pine Canyon Dam reservoir site, has been approved by the California Railroad Commission. The sale price is $783,494. The city has held an option on the plant and land since 1930.

DEVELOPMENT WORK AT SARATOGA SPRINGS, N. Y., at a cost estimated above $5,000,000 is made possible by a law recently passed in New York State setting up the Saratoga Springs Authority and authorizing it to issue bonds for the construction and maintenance of facilities required for the development of the mineral springs for public health purposes.

THE PROVINCE OF QUEBEC led all other provinces in Canada in construction during the year 1932, according to figures recently made public. Quebec did more than $52,000,000 worth of building last year, a little under 40 per cent of the total for all Canada, the total for the country amounting to $132,872,000 or a decline of 58 per cent from the 1931 figure.

COMPLETION OF THE EASTERN STATE PARKWAY, New York, from the Hollow road at Peekskill to the Cold Springs-Carmel road is authorized by a bill recently approved by the Governor of New York.

A REINFORCED CONCRETE RIVER WALL at Helena, Ark., 3,100 ft. long and built to withstand a flood nearly 8 ft. above the crest of the 1927 flood, has been completed at a cost of over $150,000. The wall starts north of the municipal terminal and extends south to the grain transfer station where it joins the new levee enlargement.

HEARINGS OF VALUATIONS of hydro-electric properties having investments of nearly $60,000,000 have been begun by the Federal Power Commission. The projects include the Waterville plant in North Carolina, the Chelan project in Washington, the Lewiston project in Idaho, the Eldorado project in California, the Oak Grove project in Orgeon and the Clarion River development in Pennsylvania.

EXPORTATION OF POWER from the province of Quebec to the United States, forbidden for the past six years, is now permitted under legislation recently approved by the Lieutenant Governor of the province. Power in amounts up to 300,000 hp. may be exported, the province collecting a tax of $2 per horsepower. Export of the surplus power of existing plants in the province of Quebec into the United States will reduce the market for power from the proposed plant in the international section of the St. Lawrence river.

Engineering Contracts and Capital

HEAVY engineering construction contracts reported for the past week total $11,455,000, a gain of 50 per cent over the previous week's low volume of $7,636,000. The average of contracts awarded the last four weeks is $12,348,000, as compared with a weekly average of $25,568,000 for the same month last year. Public works accounted for $6,012,000 of the past week's total. Federal awards amounted to $1,561,000, a gain over the previous week but still a low figure due to the government's ban on new contracts pending a public works program. State and municipal work totaled $4,451,000, which included materials contracts let by the Virginia department of highways aggregating $1,597,000. Private awards were heavier than usual, amounting to $5,443,000, including a mausoleum contract in California amounting to $1,000,000, and the award of three bridges at Richmond, aggregating $1,079,000. The bridges are to be financed by the R.F.C.

Bids have been received for the driving of the Iron Mountain and Coxcomb tunnels on the Colorado River aqueduct. Low bids for this work aggregate $7,325,000. Low bids amounting to $2,103,000 have been received for highway work in Indiana.

New productive capital issues sold last week totaled only $785,000, all public bonds. Nine loans were approved by the R.F.C. aggregating $1,134,000.

Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

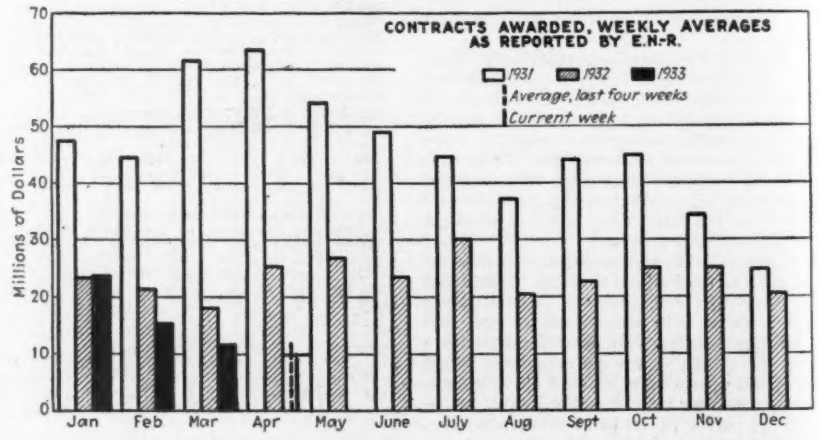
	Weekly Average Apr., 1932	Four Weeks	Week Apr. 27, 1933
Federal government	$2,912	$1,757	$1,561
State and municipal	14,799	5,060	4,451
Total public	$17,686	$6,817	$6,012
Total private	7,882	5,531	5,443
Week's total	$25,586	$12,348	$11,455
Cumulative to date			
1932		$371,785	
1933		263,232	

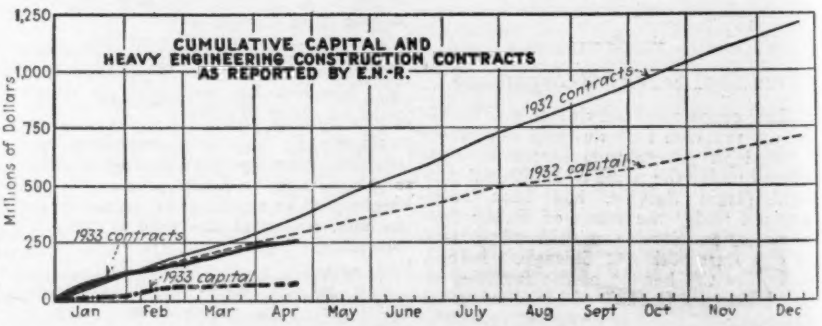
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Weekly Average Apr., 1932	Four Weeks	Week, Apr. 22, 1933
New capital issues	$11,500	$1,145	$785
Cumulative to date.			
1932		$283,500	
1933		72,986	
R.F.C. self-liquidating loans:			
Approved current week			$1,134
Approved to date (including 1932)			203,305
Actual loans made (including 1932)			20,461

ENR Cost and Volume Index

E.N.-R. Cost		E.N.-R. Volume	
April, 1933	100.16	March, 1933	62
March, 1933	158.44	February, 1933	82
April, 1932	153.12	March, 1932	97
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	226
1930 (Average)	202.35	1930 (Average)	260
1913 Average	100		

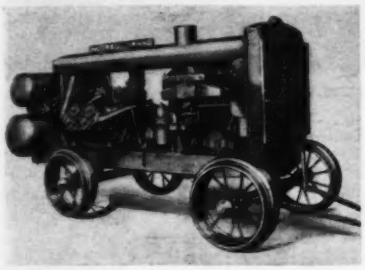




Construction Equipment and Materials

Two-Stage Air-Cooled Portable Compressor

Ingersoll-Rand Co., 11 Broadway, New York, N. Y., is introducing a new portable two-stage air-cooled compressor. It has two low pressure cylinders, arranged in a V, and between them, in vertical position, a high-pressure cylinder. Partially



Ingersoll-Rand compressor of two-stage air-cooled type

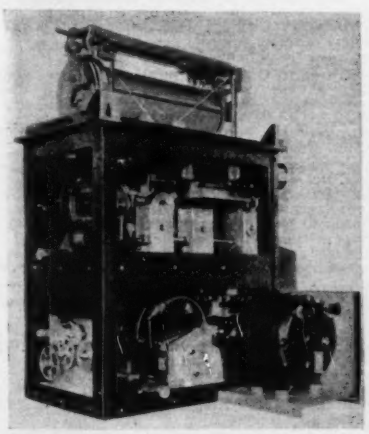
compressed air from the low pressure cylinders passes through an intercooler. Cooling is effected by air drawn through the intercooler network by a fan.

A Waukesha four-cylinder gasoline engine designed expressly for this service, supplies the power. A clutch for easy starting is interposed between engine and compressor. The new machine is made in four sizes, having piston displacements of 125, 185, 250, and 370 cu.ft. per minute.

Recorder-Controller for Materials Testing

An announcement has been made by Baldwin-Southwark Corp. of Philadelphia, Pa., of a new automatic recorder-controller for materials testing to be used in conjunction with the Southwark-Emery System of hydraulic load production and

Fig. 1 — Recorder - controller mechanism which in conjunction with a strain gage attached to the specimen produces a stress-strain graph and automatically controls the application of load by the testing machine. Note the Bourdon tube.



measurement. The new instrument is a combination of extensometer, Bourdon tube and hydraulic valve in association with motors, relays, solenoids and mechanical clutches. The extensometer or strain gage is fundamentally a micrometer screw in combination with a mechanical lever multiplying system (Fig. 2). Its sensitivity is such that a 0.00002-in. strain may be made to produce a perceptible motion of the recording pencil, while the accuracy is plus or minus 0.00005 in. Stress is measured by the Bourdon tube. By suitable mechanical means, the motion of the free end of the tube is transmitted to an indicating hand or a control arm. Since the motion of the free end of the tube is a function of the pressure in the tube, the control arm indicates pressure, or in this case load, which is recorded on the rotating drum. The guaranteed accuracy is ¾ per cent of the load from 10 per cent capacity to 100 per cent capacity. The Bourdon tube and strain gage give, respectively, the two elements needed for stress-strain diagrams.

For the achievement of constant rate of strain variation (by the controller part of

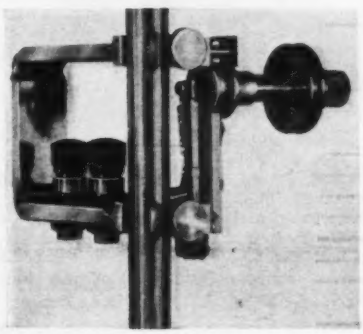


Fig. 2—Strain gage which relays the varying gage length to the recorder-controller.

the mechanism) it is necessary to provide a moving contact (Fig. 1) along the path of the pencil travel, that is, along the ordinate of the stress-strain graph. The velocity of this moving contact is controlled by a small synchronous motor and a group of readily changed gears located in the box below. The design offers twelve speeds—six on an inches-per-minute basis and six on an inches-per-hour basis, or, in other words, speeds from 0.0001 in. per in. gage length per hr. to 0.002 in. per in. gage length per min.

The synchronous-motor-controlled moving contact serves as control for a power-operated hydraulic valve (Fig. 3) which admits fluid to the load-producing cylinder of the testing machine. In this way the strain in the specimen is controlled as to time-rate by the quantity of fluid admitted to the cylinder from the pressure supply. Electrical controls also are made to determine the quantity of fluid admitted to the cylinder and therefore the time-rate of load application.

Provision is also made for applying a constant load over a considerable period in which case the valve is controlled so as

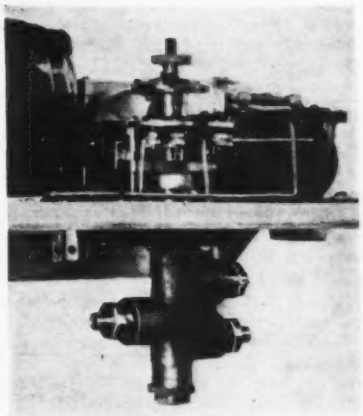


Fig. 3—Motor and operating gears with the hydraulic valve (below the base plate) that controls the rate of load application.

to admit only enough fluid to the cylinder to compensate for creep, if any, and for leakage in the hydraulic load-producing system.

New Equipment

Single-Suction Pump. Buffalo Pumps, Inc., Buffalo, N. Y., has introduced a self-priming single-suction centrifugal pump. The self-priming device, built under license from the Nash Engineering Co., is mounted as an integral part of the pump casino.

Curing Blanket. A curing blanket for concrete, made of a filler of jute fibres, contained between two layers of burlap, has been introduced by the Western Felt Works, Chicago, Ill. The blanket is coated with latex to make it slightly waterproof and to retard the evaporation of moisture from the concrete.

Waterproofing. The Master Builders Co., Cleveland, Ohio, announces "Master-seal All Weather Waterproofing," a transparent surface waterproofing which can be applied effectively on wet or dry surfaces. Application of the material is also possible at temperatures as low as 32 deg. F.

Crane Shovel. The Manitowoc Engineering Works, Manitowoc, Wis., has placed on the market the Model 150, Manitowoc Speedcrane, a heavy-duty 1½-yd. crane and shovel. The crane has a rated lifting capacity of 30 tons. All gears with the exceptions of the large ring gear and swing pinion are enclosed and run in a circulating oil system.

Speed Reducer. The Smith Power Transmission Co., Cleveland, Ohio, has announced the Johnson variable reducer, an infinitely variable speed reducer self-contained, running in a bath of oil. The manufacturer states that it will give infinite speed control from zero to any desired speed. The capacity of the unit ranges from 1 hp. up.

Portable Power Saw. A new line of portable electric saws is announced by the Syntron Co., 400 N. Lexington Ave., Pittsburgh, Pa. The saws are provided with fully enclosed blade guards and tilting bases for bevel cuts. The lower half of the guard closes completely around the blade. When the trigger switch is pulled, the lower guard opens one quarter way, enough to permit the saw blade to engage the ma-

terial. As the blade cuts in, the material forces the guard to telescope into the upper guard housing until the blade is fully exposed.

Cooling Tower. The Binks Manufacturing Co., Chicago, Ill., announces its new type "FD" forced-draft spray cooling towers for indoor installation. The towers are fabricated of a heavy galvanized copper bearing steel, with all exposed joints or rivets tinned or soldered, galvanizing being done after fabrication. Fan and motor are fastened to an angle iron supporting stand.

Wagon Track. A 15-ton drop-forged steel wagon track has been introduced by the Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Load-carrying track wheels roll on the rail of an endless track. Idlers, or end wheels, pick up the track in the rear and deposit it in the correct position ahead of the first track wheel, Overall dimension are 80 in. long, 36 in. high, 19½ in. wide. Track shoes are 18 in. wide.

Tandem Axel Trailer. The C. R. Jahn Co., Builders Building, Chicago, Ill., has announced a new tandem axel LaCrosse trailer which includes the fully reversible feature of the regular dual axle models. The trailer is built in sizes up to 72,000 lb. capacity. It can be towed from either end. Dual end steering makes it follow the turning radius of the truck. The platform is supported by heavy freight car type coil springs.

Electric Welding. The Metal & Thermit Corp., 120 Broadway, New York, N. Y., announces an addition to its line of Murex heavy mineral coated electrodes. The new unit, Murex Universal, is for use on mild steel and may be employed in either flat, vertical, or overhead work. The company states that smooth, clean deposits of high tensile strength and ductility are obtained consistently on any of these classes of work.

Priming System. A new system for automatically priming centrifugal pumps has been developed by the Pennsylvania Pump & Compressor Co., Easton, Pa. A small motor-driven rotary vacuum pump, mounted on the centrifugal pump and arranged to evacuate the air in the pump and its suction line, is started either by push button or remote control, as by change in the water level or head, and when the pump is fully primed, the motor is started. Building up of normal pressure in the discharge pipe stops the vacuum pump, but should the pump lose its prime at any time it is automatically stopped, the vacuum pump is started and the cycle of priming repeated.

Business Notes

UNITED STATES PIPE & FOUNDRY CO., has recently moved its Kansas City office to 818 Bryant Building, 11th and Grand, Kansas City, Mo.

THE CANADIAN CONRETE PRODUCTS CO., LTD., which is affiliated with the Massey Concrete Corp., Chicago, Ill., has changed its office from the Dominion Square Building, Montreal, Quebec, to P. O. Box 118, Belleville, Ontario.

JOHN TALIAFERRO, formerly eastern sales manager of the Atlantic Creosoting Co., Inc., has been promoted to vice-president in charge of the Savannah, Ga. plant. J. C. Postell, formerly vice-president of the Norfolk, Va. plant has been transferred to New York in the capacity of vice-president in charge of plant operations and sales.

New Self-Priming Pump

The Chain Belt Co., Milwaukee, Wis., announces a new 3 in. self-priming centrifugal pump, which rounds out its line of Rex speed primers. The new pump is of the recirculating type, and is automatic in action after the recirculating system is once filled.

The capacity of the pump varies from 20,400 gal. per hour at a 5 ft. suction lift to 9,000 gal. per hour at a 25 ft. suction lift. The impeller is of the open trash type with two blades, and will pass a sphere up to 1½ in. diameter. Power is supplied to

Rex self-priming centrifugal pump

the unit by an air cooled engine which develops 6 hp.

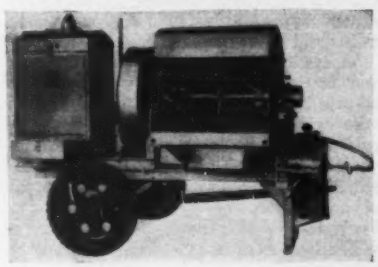
The pump and engine are mounted on a wheelbarrow frame to provide portability, and both the pump and power unit may be removed from the frame by loosening four bolts.

New Bituminous Mixer

The National Equipment Corp., Milwaukee, Wis., has recently developed a new bituminous mixer. It is built in two sizes, 6 to 8 cu.ft. and 10 to 12 cu.ft. Mixing is accomplished by specially designed, adjustable, manganese "saw-tooth" blades, having a criss-cross mixing action. A detachable heater is located at the end of the machine away from the engine.

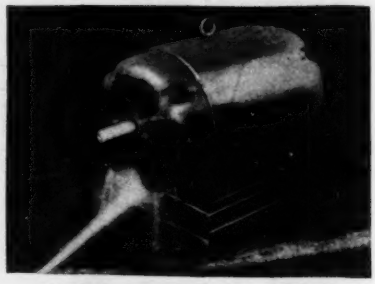
The manufacturer states that the indirect application of heat by means of a shell around the drum causes even heating, avoiding burning the material.

Mixing is accomplished by the rotation of toothed blades.



Splash-Proof Motor

The Ideal Electric & Manufacturing Co., Mansfield, Ohio, announce their splash-proof motor especially designed to be used in places where water or other liquids may be splashed about. Baffles placed in the



New motor protected against splashing

air ducts remove all spray from the air entering the motor and keep the motor windings dry at all times. It is a standard induction motor using special bearing brackets.

New Publications

Truck Mixers. The Jaeger Machine Co., Columbus, Ohio, has issued a 32-page catalog describing the truck mixers, agitators paving mixers, spreaders and transfer plants manufactured by the company.

Tarvia. The 1933 edition of the Barrett Road Book has been published by the Barrett Co., 40 Rector St., New York, N. Y. The book consists of 48 pages and contains a number of tables useful to the highway engineer.

Super Cement. A 24-page bulletin has been published by the Lawrence Portland Cement Co., 270 Broadway, New York, N. Y., describing Dragon super cement and illustrating the uses to which it has been put.

Tractors. The Linn Manufacturing Corp., Morris, N.Y., has published a 16 page bulletin describing the tractor equipment built by the company. The publication emphasizes the patented flexible traction feature of the Linn tractor.

Aluminum. "Combating Chemical Corrosion with Alcoa Aluminum" is the title of a 43-page pamphlet issued by the Aluminum Company of America, Pittsburgh, Pa. There is included a detailed list of the effects of various chemicals and chemical compounds upon aluminum.

Clutches. The Twin Disc Clutch Co., Racine, Wis., has issued a 10-page illustrated booklet entitled "Selecting the Clutch" which covers the various phases to be considered in the correct clutch selection for any type of machine where power must be transmitted.

Air Tools. The Gardner-Denver Co. has issued a new 24-page General Products Bulletin illustrating their line of portable air compressors, rock drills and accessories. Copies may be obtained by writing to the company at Quincy, Ill., or to any of its branch offices.

Toncan Iron. The Republic Steel Corp., Youngstown, Ohio, has published a 10-page folder giving comprehensive data on the properties of Toncan copper-molybdenum iron. In addition to higher resistance to rust, Toncan iron is unusually soft and ductile, the company states.

Compressors. The Sullivan Machinery Co., Chicago, Ill., has published an 8-page catalog, Bulletin 88-D, describing the single-stage angle-type compressors made by the company for low-pressure gas and air service. The units are driven by direct-connected electric motors, diesel engines, by steam engine or by belt.

Sewage Equipment. Municipal Sanitary Service Corp., 155 East 44th St., New York, N. Y., has just published a series of pamphlets describing sewage-treatment equipment, including pneumatic ejectors for sewage screenings, fine screens of the Riensch-Wurl disc type, vacuum filters for sludge, Schofield bar screens, Decarie screenings incinerator, and vacuum filters for sewage filtration.